VOL. I. No. I.] JULY 1, 1875. [PRICE FOURPENCE.

THE ELECTRICAL NEWS AND TELEGRAPHIC REPORTER.

Edited by WILLIAM CROOKES, F.R.S., &c.

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LONDON: BOY COURT, LUDGATE HILL, E.C.

1875.

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Vol. I.—No. I.] July 1, 1875. [PRICE, 4d. POST FREE, 4½d.

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LONDON:
PUBLISHED AT THE OFFICE, BOY COURT, LUDGATE HILL, E.C.
AND SOLD BY ALL BOOKSELLERS.

MDCCLXXV.

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PRINTED BY WILLIAM CROOKES, ELECTRICAL NEWS OFFICE,

BOY COURT, LUDGATE HILL, E.C.

THE ELECTRICAL NEWS.
VOLUME I.

EDITED BY WILLIAM CROOKES, F.R.S., &c.

No. 1.—JULY 1, 1875.

TO ELECTRICIANS EVERYWHERE.

SINCE the day when Electricity was first discovered, until now, its vast importance and its high destinies have grown upon the human mind. Fresh phases of its power, fresh results, new means of obtaining and governing its action, and multiplied ends to which it may be turned, have constantly discovered themselves; till to-day it stands out as one of the grandest subjects presented to the scientific and practical world for investigation and research. Perhaps, however, no other Science or Art has exhibited so extraordinary a concurrence of anomalies. It is at once the most terrible monster and the most humble and obedient servant, its action is at one moment beneficial, at the next destructive; its range is boundless, yet it may be "cabined, cribbed, confined" at ease; it is everywhere present, while its nature is only imperfectly understood; and, to crown all, although it is one of the most important agents in the action and the phenomena of the universe, and increasing knowledge of its applicability to the needs of our race is of the utmost importance, no direct means of ascertaining the thoughts and discoveries of its students, or of bringing them before the scientific and mechanical community, at present exist. Attempts have been made to supply this want, and journals have been started with the professed object in view of making public all that is known or can be learnt of Electricity in all its branches. But they have degenerated into unscientific records of unimportant events, and the purpose for which they were established has been lost sight of. Thus it comes that—while Engineering, Chemistry, and other Applied Sciences have all their representative recognised organs—the Electrician finds himself without any current journal from which he can learn the events which are daily occurring of peculiar interest to himself.

Such a want will now be supplied by the establishment of the ELECTRICAL NEWS AND TELEGRAPHIC REPORTER, of which this is the first number. In its columns will be found the most valuable opinions of eminent Electricians and scientific men all over the world. Articles will be contributed which will be of value not only to those who study Electricity as amateur experimentalists or scientific inquirers, but also to those whose daily life is bound up with the advancement of practical knowledge in all departments of the science, and who as electricians, telegraphists, electrotypers, electroplaters, and chemists have continually to deal with the same marvellous agent of force in different ways. Nor will the doings of foreign societies be ignored as in times gone by, but, in the shape of carefully prepared abstracts, their proceedings will be presented to our readers. Every opportunity will be given for the healthful discussion of the science in all its branches, and a fair unbiassed course will be steered in all questions of dispute.

This, then, is our Programme in brief. More we could promise, but prefer to let the new periodical speak for itself. The subject with which it will deal is of too great importance to need one word of recommendation. Daily experience teaches us that we are as yet on the threshold only of a vast expanse of electrical

knowledge. This has to be explored, and as the research gains in strength and intelligence the results will be far beyond all present conception. The feat of girdling the earth in forty minutes will be eclipsed by great deeds yet to be done, and if the establishment of the ELECTRICAL NEWS AND TELEGRAPHIC REPORTER conduces to the hastening of this desirable end our object will have been gained, and we shall be fully rewarded.

ON TUBULAR ELECTRO-MAGNETS WITH MULTIPLE CORES.

By the Count Th. DU MONCEL,

Membre de l'Institut de France; Officier de la Légion d'Honneur et de l'Ordre de St. Wladimir de Russie; Ingénieur-Electricien de l'Administration des Lignes Télégraphiques Françaises.

IN a note presented to the Academy on the 1st of last March I referred to certain experiments which I had made in 1862 on tubular electro-magnets, and I pointed out, among other important results, that these electro-magnets have the same energy as solid electro-magnets of the same diameter, if care is taken to fit their polar extremity with a stopper or a shield of iron. The electro-magnets of M. Camacho having latterly somewhat complicated the question, I have undertaken a new series of researches upon tubular electro-magnets with multiple cores, of which I am about to give the first outline.

I wish it to be observed that in my experiments I have always employed, to measure the electro-magnetic energy, the effects of the attraction at a distance. It is, in my opinion, the sole means for obtaining exact and comparable measurements, and these are also the effects which it is most interesting to study, since they determine the mechanical action in those apparatus where these instruments are employed. I shall be led to believe that the contact-attraction in tubular electro-magnets does not always behave in the same manner as the attraction at a distance; but I shall subsequently examine this side of the question.

The electro-magnet with which I have made my experiments is one of those which M. Camacho has constructed. Each limb is composed of three tubular cores, one introduced into the other, at the respective distance of 2 m.m., and of a solid central core. The whole is fastened at one extremity to a breech-piece of soft iron, 8 centims. long, 3½ wide, and 1 in thickness. The tubular cores are 6¼ centims. in length and 2 millims. thick, and the central core is 6 m.m. in diameter, which gives a diameter of 3 centims. for the complete limb.

Each of these cores is enfolded with a magnetising coil of copper wire $\frac{8}{10}$ths of a m.m. in diameter, but the last coil has five rows of spirals, whilst the others have only two. The ends of the wires of each helix spring from the breech-piece of the electro-magnet, and can be connected in such a manner that the current passes successively from one coil to the other by the opposite ends, or traverses them all simultaneously, just as the elements of a battery can be arranged either for potential or for quantity.

The construction of these electro-magnets being very delicate, it is difficult to obtain the same conditions of force from their limbs acting separately. To ascertain the part of this difference of action in the observed effects, I have found it needful to study separately the attractive force of each limb and that of their cores. On the other hand, as the forces measured could not be comparable, except in circuits of the same resistance, I have been obliged to have recourse to a differential galvanometer and a rheostat to bring these resistances into equilibrium. The experiment was arranged as follows :—

In one of the circuits of the differential galvanometer I introduced a constant resistance of 600 metres of telegraphic wire, and in the other a rheostat connected to the wire of my electro-magnet. I then developed upon the rheostat, at the moment of every experiment, the resistance necessary to keep the galvanometer at zero. The following are the results obtained with a Bunsen element of medium size, repeating the experiments twice in an opposite direction, and estimating the forces in grammes at an attractive distance of 1 m.m. Naturally, the electro-magnet reacted upon the armature in the manner of a damaged electro-magnet when I tried each limb separately.

	Resistance on the Rheostat.	Resistance of the Coils.	Attractive Force.
		Metres.	Grms.
1. With all the coils or helices connected, end to end	27·75	315·29	104
2. Outer coil alone	36·62	224·23	45
3. Third „	54·00	45·96	6
4. Second „	55·75	28·01	3
5. First „	57·37	11·33	1
6. Simple circuit..	58·50	—	—
7. The two branches joined up	8·75	510·02	520

I shall not give the figures belonging to the left-hand coil, for the inner helices, being badly insulated, the outer helix alone exerted its effect. These figures, moreover, could have no interest. I will merely mention that the resistance of the outer helix was represented by 192·17 m., giving rise to an attractive force of 42 grms., and that all the helices joined together only presented a resistance of 194·73 m. and an attractive force of 44 grms.

The foregoing figures already allow us to deduce, as a very important conclusion, that *the force developed by all the helices combined is almost twice as great as that which results from the sum of their individual actions*, which is only 55 grms. As we cannot admit that these individual actions are in more unfavourable conditions with respect to the magnetic cores, and for a given electric intensity, than in the case where the magnetising helix is formed by one single and identical wire coiled around a solid core, we must infer that *the tubular arrangement, with distribution of the helix over several cores, is decidedly favourable to the development of the electro-magnetic force.* To what cause this superiority is due we are about to attempt to elucidate.

At first, when we consider that the magnetising action cannot penetrate deeply into the magnetic mass, as M. Jamin has demonstrated, we might believe that the cause should be attributed to a better utilisation of the magnetising action, which acts in this manner upon the whole magnetic mass of the core. But this cause is evidently not the one which preponderates, since the sum of the forces determined separately upon the core is far from corresponding to that produced by the simultaneous action of the helices. There is, consequently, another cause which acts powerfully, and which is evidently connected with the reciprocal reactions of the magnetised cores upon each other. To recognise this cause, it became needful to study separately these different actions, and to arrive at this point I have been obliged to undertake a series of experiments for the purpose of determining :—

(1). The polarity of the different cores, according as I magnetised such or such a one of them.
(2). The individual force developed upon each.

The experiments are very delicate, by reason of the manifold reactions which are set up, but I succeeded in

isolating them, first, by taking the polarities by means of long rods of iron, which I supported by one of the ends upon these different cores, and by which I caused to disappear the magnetism remaining after each experiment; and by measuring the attractive force no longer by the aid of the armature of my magnetic balance, which received all the influences at once, but by cutting off the top of a small cylinder of soft iron of 2 m.m. in diameter, which I applied by the end to the different cores, and which I removed by the aid of a balance.

The verification of the polarities, developed at the moment of each of the experiments of which we have been speaking, convinced me that *all the cores placed in the interior of a tube, directly magnetised by the helix which surrounds it, have the same polarity as the tube itself, but that those which surround it externally are feebly polarised in the contrary direction*, as takes place in simple tubular electro-magnets covered with an iron breech-piece at one of their ends. These effects have nothing about them but what is very natural, since the exterior tube constitutes, in this case, a mere expansion of the pole determined on the breech-piece, and because the enveloped tube or tubes are submitted to the direct action of the solenoids, either voltaic or magnetic, which result from the circulation of the current across the helix, and from the magnetisation of the core which this helix covers. Thus, when we magnetise only the central nucleus of the electro-magnet of which we have spoken, if there is developed a north polarity at its free extremity, south polarities will appear on the other cores. If, on the contrary, the helix of the second core is traversed by the current, this second core and the central one will exhibit north polarity, whilst the third and the fourth will be polarised south &c.

The individual forces of these different cores differ a little according to the position of those directly magnetised by the helix; but *the difference is little perceptible*, and the most energetic force corresponds to the core whose helix is set in action. I speak only, be it distinctly understood, *of the surrounded core, for the enclosing ones do not determine any sensible attraction.* In the experiments undertaken with the Bunsen element, of which I have already spoken, and an exterior circuit without resistance, the attractive forces of the cores thus magnetised have reached 850 to 950 grms. But a point very important to verify is that, when the current traverses all the helices at once, *the central part, contrary to what takes place with a solid core, becomes the centre of action.* Of this we may satisfy ourselves by suspending a small cylinder of iron at 2 or 3 m.m. above the limb of the electro-magnet experimented upon. When the current passes through all the helices, this cylinder is attracted towards the centre. On the contrary, when it passes through a single helix only, the cylinder is drawn towards the tube corresponding to that helix.

We may, as it appears to me, conclude from these experiments that, independently of the peculiar action exerted by the interior helices, *the magnetisation of a single one of the cores suffices to involve that of all those cores which it encloses*; and this action repeating itself for each of them when the current simultaneously traverses all the helices, there results—at least, for the interior cores—a superposition of magnetic actions effected in the same direction, which naturally produces its maximum effect upon the central nucleus, since it is enclosed by all the others. Now, does the sole action of a magnetised core upon those which it envelopes give rise to a magnetic force greater than when this core is solid? This experiment does not demonstrate. In fact, on taking the iron tube which had been used for my experiments in 1862, and submitting it to my magnetic balance, at first alone, and afterwards with an iron cylinder which entirely filled it, then with two small cylinders of 0·006 m. and 0·008 m., leaving between them and the sides of the tube an interval, respectively, of 2 m.m. and of 1½ m.m., I obtained the following results:—

	Bunsen 1 element. grms.	Daniell 12 elements. grms.
1. Tube alone	37	21
2. Tube filled with iron cylinder ..	47	30
3. Tube with core of 0·006 m. ..	45	26
4. Tube with core of 0·008 m. ..	45	29
5. Tube with iron stopper	45	30
6. With solid core	48	31

On adapting a mass of iron to the inactive pole and consequently uniting magnetically the central core with the tube, as in Camacho's electro-magnet, the force becomes in one case 88 grms. and in the other 63 grms. But it reaches exactly the same figures with the solid core. It is therefore not to the division of the magnetic core into several that the electro-magnets of which we are speaking owe their greater energy, but rather, as I have already said, to the superposition of the magnetic effects which these different cores develop, and consequently by their mutual reaction when magnetised by their helices.

To explain the influence which the greater or less saturation of these cores may exert upon the effects of tubular electro-magnets with multiple cores, I have repeated the experiments of which I spoke at the commencement of this notice with a Daniell's and a Bunsen's element, introducing no artificial resistance into the circuit. I obtained the following results with an attractive distance of 3 m.m. when employing the Bunsen element, and of 1 m.m. with the Daniell's element:—

	Daniell's element.	Bunsen's element.
1. With both branches united ..	47	182
2. All the helices connected of the right coil ..	27	167
3. Exterior helix alone	19	162
4. Helices 1, 2, and 3 connected	4	150
5. Helix No. 3 alone	1	140
6. Helix No. 2 alone	—	52
7. Helix No. 1 alone	—	5

These figures show decisively that the advantageous effects of the electro-magnets of which we are treating are more manifest with a weak than with a strong magnetic saturation, but there is room to consider that the resistance of the Daniell's element being much greater than that of the Bunsen the variations of resistance of the helices are less felt in the one case than in the other. We must also take into consideration the conditions of the maximum of force of electro-magnets which have been almost fulfilled in the first experiments and not in the second. It results that the force of the two branches with the Bunsen element is relatively too weak, and that the force in relation to the outer helix is relatively too strong. We recognise that in spite of the considerable increase of energy which the individual attractions of the different cores have acquired in consequence of the reduced resistance of the circuit, it is still the disposition with the union of all the helices which gives the greatest force.

In the researches which I have planned on the tubular electro-magnets with multiple cores there is a point which claims particular attention. It is to find if caps of iron adapted to the polar extremities of these sorts of electro-magnets are useful or not in the development of the attractive force.

The question has need, however, to be narrowed, for according as these caps or shields of iron are arranged in the interior of the tubular cores or above, the electro-magnet is placed in very different conditions of magnetic distribution, and naturally the resulting attraction cannot be the same. I have made on this account a certain number of experiments which allow of indecision.

When the caps are simply applied upon the concentric rings which terminate the tubular cores, so as to connect them magnetically, the thickness of these caps removes from the extremities of the helix, that is to say, from the point where the magnetic polarity is most energetic, the

portions of the magnetic cores whose function is to determine the attraction, and they ought consequently to have the effect of diminishing the magnetic force. This is what M. Camacho had already recognised and what I have convinced myself of by very precise experiments. Thus whilst the electro-magnet without caps would produce at a millimetre of attractive distance a force represented by 72 grms., with caps of 4 m.m. in thickness it would only exert an attraction of 58 grms. And this difference of action is not peculiar to tubular electro-magnets, for it is also recognised even in bundles of magnetised rods. We see, for instance, that a magnetised bundle, one of whose poles is able to attract an armature loaded with 26 grms. at the distance of 1 m.m., when not fitted with an iron cap, cannot excite this attraction when provided with such a disc, and in order that the attraction may take place the weight must be reduced to 15 grms. In order that we may form an idea of the influence exerted by the greater or smaller removal of the polar extremities of a magnetic core from its magnetising coil, it may suffice to say that the solid core of the bobbin (which had served in my experiments of 1862) having been arranged so as to have its polar extremity level with the cap, excited at the distance of 1 m.m. an attraction of 34 grms., whilst it furnished a force only of 27 grms. when this polar extremity was advanced 5 m.m. outside the coil; which is but natural, since the greater the surface upon which a magnetic pole is expanded, the less energetic is the exterior action which it exerts.

When the caps or discs are introduced into the inside of the tubular cores, and when they do not change the position of the extremities of these cores with respect to their magnetising helices, they considerably augment, as we have seen, the electro-magnetic force, at least with simple tubular electro-magnets; but it is not the same with tubular electro-magnets having multiple cores. In such electro-magnets these caps can only be kinds of flat rings introduced into the different cores, and they must exercise a prejudicial action by playing the part of lateral armatures. We have seen, in fact, that in tubular electro-magnets with multiple cores, the interior play, up to a certain point, the part of the iron stoppers in simple tubular electro-magnets. Consequently, under their influence, the magnetic core in its totality is found almost in the same conditions as if it was solid, and the rings can therefore only occasion a pure loss of one portion of the magnetic action developed. I have, further, shown in an earlier paper that a ring of iron adapted externally to a simple tubular core diminishes the force which the latter develops, even when it is internally fitted with an iron stopper. Is the increase of the polar surface represented by the circular section of a tubular core prejudicial to the magnetic action developed? Evidently not, as experiment demonstrates in a perfectly distinct manner. We have seen, in fact, that on successively introducing into a simple tubular core the two cylinders of 0·006 m., and of 0·008 m. in diameter, the force developed was 29 grms. for the second, but only 26 grms. for the first. There is, I think, this difference between the effects produced in this latter experiment, and in those which precede it; that in the one the core reacts like a magnet furnished with a piece of iron at its active pole, whilst in the other it behaves like a magnet regularly formed, and not disturbed by any lateral reactions. However this may be, these are the results of the experiments which I have made on one of the limbs of the Camacho electro-magnet, with or without iron rings, employing a Bunsen element feebly charged: the attraction was effected at the distance of 3 m.m.:—

	With Rings.	Without Rings.
1. With all helices combined ..	106·0	122
2. Outer helix alone	102·0	113
3. Helices 1, 2, and 3 combined..	68·0	102
4. Helix No. 3	64·0	82
5. Helix No. 2	20·0	38
6. Helix No. 1	0·5	6

These experiments have been repeated three times in an opposite order, and the results have always been approximately identical.

The conclusion from these experiments may be that we ought to banish iron appendages from magnets. But if we consider that they enable us to make the magnets react upon their armatures in better conditions of proximity and adjustment, and that iron possesseo a magnetic conductibility much greater than that of steel, and, above all, than natural magnets—a conductibility which permits a more easy concentration of the magnetic action —we conclude, that in spite of the loss of force which they may involve, these fittings are eminently useful, and even so much the more useful as the point of maximum magnetic saturation being much more remote in iron than in steel, these fittings may concentrate on a smaller surface all the magnetic force of a collection of cores.

THE COPPER-ZINC COUPLE AND ITS EFFECTS.*

By J. H. GLADSTONE, Ph D., F.R.S.,
Fullerian Professor of Chemistry in the Royal Institution.

I PROPOSE, ladies and gentlemen, to bring before you in this lecture a series of researches which have been made during the past two or three years by Mr. Tribe and myself. They have been made partly in my own private laboratory and partly in the laboratory of this Institution. They have been made by what we call the copper-zinc couple, and my first duty, I think, will be to explain the principle of that couple.

We have here a simple galvanic cell: that is to say, we have two different metals in this case,—copper and zinc, —because I mean to keep to zinc and copper pretty much during this afternoon. Now, at present the metals are not connected with one another except by that liquid. The liquid is dilute sulphuric acid. At present there is a magnet just taking up the ordinary course of the meridian. We have placed it so, and you see that the magnet points towards those two metals, because that is the direction of north and south. Supposing I connect those metals by any metallic junction,—such, for instance, as this other piece of zinc, with which I will join the two metals,—we shall see that something takes place. That magnet, you see, is at once started, and swings round to one side considerably, and will remain permanently on one side, while, at the same time, you will observe that there are bubbles of gas forming on this copper plate, and rising up to the surface of the liquid. I think that the contact has been broken for a moment. Now I will make it again, and you perceive that again this magnet swings, and the bubbles of gas rise upon this copper plate.

Now, how are we to conceive of this? There is some change taking place. There is no action taking place between this copper plate and the liquid in the way of decomposition. It is this zinc which is dissolving off; but, at the same time, this hydrogen which is being given off by the action of the zinc is actually given off at about 10 inches distance on the copper plate. That there is something going on is evidenced by the moving of the magnet. It is true that this magnet is affected by two things here, the liquid and the connecting metal. It may be affected by either of these two things, and at present it is being affected by both. Now, how are we to conceive of what is taking place under those circumstances in the liquid.

Well, we must have some kind of theory—some kind of view. It is very difficult for us to imagine exactly what is taking place; but still I endeavoured to illustrate it in the juvenile lectures by means of a moving diagram. Here is a diagram representing two plates. Here is a

* Verbatim report of a Lecture delivered at the Royal Institution, London.

plate of copper, and there is a plate of zinc. Well, then, these are supposed to be in metallic connection one with the other, and the liquid between them is subjected to some kind of strain,—some kind of tension,—and therefore some kind of change takes place in it. Now, we believe that in the first instance the molecules—or little parts of which it is composed—arrange themselves in some particular order; that, in fact, the oxygen turns itself towards the zinc, and that the hydrogen turns itself in the direction of the copper. What takes place? The oxygen from the sulphuric acid—for it is sulphuric acid in the cell of which I have been speaking—combines with the zinc, and the zinc dissolves away and comes out into the liquid, and, at the same time, the hydrogen is deposited upon the copper. You may suppose that these spots represent the hydrogen. The hydrogen is being deposited on the copper, and goes away. Then more hydrogen comes in occupying its place, because it is always passing on. This hydrogen passes away also; more hydrogen comes, and in the meantime the zinc is dissolved and is going off into the liquid. The sulphuric element remains in about the same place, but there is constantly a passage of the hydrogen which is being thrown off. [The molecular changes were represented by means of the working diagram.]

Well, perhaps I may have illustrated this sufficiently. We may go on, in fact, in this way till all the hydrogen is expelled, and we have the whole thing filled simply with zinc. Well, that is one conception that we may form of it. Supposing, instead of this, we take another —a somewhat crude contrivance. Here I have arranged a number of balls, which may represent the sulphuric acid and the hydrogen. These are the sulphuric element, and those are the hydrogen, and I have placed them alternately. Now we will suppose that a force is exerted here,—this galvanic force, or electromotive force, or chemical force,—whatever you please to term it. Some force is exerted upon the particles of zinc and copper. We will represent this force by the falling of some little balls. Then what happens? The force goes through the whole, and there is very little change here, but a considerable amount of change at the other end. One of these pieces flies out. I cannot go on with the experiment now, because I shall have to change the order of these balls. But suppose that this change is made. Well, I make that change, and then there is a fresh impulse given, and also more hydrogen sent off in this way. [Illustrating.] This is a rough and very crude idea of what may be taking place in that liquid. But what I want to draw your attention to is that there are several things that prevent that action being as perfect as possible.

The whole amount of force that is capable of being generated by that zinc plate, and by that copper plate, is not employed in the liquid, in the decomposition of that liquid, and I will point out to you where there are two sources of loss of force. If I make these touch together, at once we shall see that an action takes place, and our magnet swings. But these junctions are very imperfect indeed, and there is a certain loss of force in them. If, instead of taking a piece of metal like this I had taken a very long wire, as we employ in our electric telegraphs, of course the loss would have been much greater. But that loss of force is nothing compared with another. That is what is called the external resistance. Sometimes it is very great, but in this case it is not very great. But there is a loss of force in the liquid itself, by the resistance of the liquid. The liquid does not yield readily to the strain. There is something—there is a power in the liquid itself which holds its particles together, and it will not be influenced at once or readily by the galvanic current that passes through. Now, this resistance varies with different liquids. With all liquids it is considerable. Even with the dilute sulphuric acid which we have here it is very great indeed compared with what it would be if a metal were between the two. But suppose that, instead of taking sulphuric acid, I had taken pure water; it would have been very much greater. Supposing I had taken some organic liquid, such as alcohol, it would have been greater than in the case of water. Let me illustrate it in this way—very roughly indeed. Now suppose that we are operating with this illustrative apparatus, and we take our force; what do we have? Supposing we have a certain force—the force of this falling ball striking upon the end; what shall we have? A certain effect produced at the other end. Away goes our ball to that distance. Well, we will mark that distance. Well, now we will take balls of another substance. These are balls of another kind, which we may suppose to represent atoms of another nature; but we will employ the same force. These are wooden balls, and the others are some kind of porcelain or stone-ware. We will employ the same force by means of this falling ball, which represents the electromotive force. But now we have got a different material to deal with—a different material through which to send our shock; what will be the effect? Now, you see, the ball does not go to the same distance. You can easily understand that it depends upon the nature of these particular balls how far the force will be transmitted. It depends upon whether they are more or less elastic, and hence I use this as an illustration of the amount of resistance that is offered by different liquids.

This resistance differs according to circumstances. I think that we might show you that in another form. You will probably remember that when I took all these balls, and caused the force to be exerted on all of them, the ball at the end did not travel very far. I will repeat the experiment. I will cause the force to be exerted, and you will see the distance to which it sends the ball from the end. Supposing I had taken a much shorter distance—a much smaller amount; we should find that, without doubt, the same force would send it very much farther.

Well, now, I want to show you that with regard to water. I have here a little pure water in this vessel, and we want to arrange it so as to see whether distance—whether the length of the water—has not a great deal to do with this phenomenon. I take here the same metals which I have employed before—the zinc and the copper. I have wires passing through this apparatus—this Thomson's galvanometer—which I need not explain to you now. What I want to draw your attention to is this—that a feeble current passes through that apparatus, and we are able to show the movement of a small magnet—a very minute, delicately suspended magnet—which is there, and which has a mirror upon it. The light from this lamp will be reflected from the mirror, and will be thrown upon the screen. We must allow the beam of light to come to rest. You see there it is, just at the edge of the screen, swinging backwards and forwards. Now suppose that I were to place thse metals into the water: you perceive that it brings the beam of light to a certain distance. There is a certain amount of force going through the instrument, and it moves the beam of light away, bringing it fairly on to the edge of the screen. Now at present I have about 2 inches of distance of water. Supposing I take about half that: you perceive that then the image of the mirror is brought farther on the screen. There is more action, more movement of the magnet. Supposing I bring it a little nearer still. Then you perceive that they come nearer and nearer to one another. As I advance, and bring them close to one another, you perceive that then the image advances farther and farther, and I will endeavour to bring them nicely close by the side of one another. There you see, the beam has advanced considerably from the edge. It is swinging backwards and forwards, it is true, but still it has considerably advanced. Now I will move the metals nearer, and you see that the beam has moved to a more advanced part of the screen. I do not think that I need push it further in order to show that the amount of distance in the water has a great deal to do with the amount of movement, and that the water offers a large amount of resistance. If I take only half the amount of water a larger amount of

the current passes through, and thus the image travels farther along the screen. If I bring the two plates very close to one another, as I did in the last instance, we bring the image considerably on to the screen. I will do it again. There it goes with a good swing. This shows that we have a considerable amount of force.

Now, I want you to bear in mind very distinctly that this resistance varies very much with the length of the liquid that is between the two metals.

Now, the virtue of our copper-zinc couple is that, by means of it we are capable of getting rid entirely of any external resistance, and reducing the internal resistance of the liquid to the very minimum. We take zinc and we deposit copper upon it in a myriad of different places, and we immerse the whole into water, or any other liquid that we want to act upon. Then, of course, there is no external agent at all, because the whole thing is inside the water, or the liquid that is to be acted upon; and as to the distance of the water, the water will wet the whole thing. It will go round the zinc and the copper and be acted upon. But I must show you that by means of the microscope. We will take some zinc, and I will show you how the zinc decomposes the copper solution. If I put zinc into a copper cell, the zinc will take the place of the copper, and the copper is thrown down upon it. [A magnified shadow of the vessel and preparation was thrown upon the screen.] There is the zinc, and there is the copper. The copper will pass out of solution and be deposited on the other piece of copper, and the zinc dissolve.

We have already made some preparations. We have taken some zinc, and if we put some zinc in the copper solution the copper is deposited on the zinc; but it is deposited slowly: at least, I think it would tire your patience if you were called upon to wait for it. Here is some that has been prepared a little while before the lecture, and it has grown. This black piece is the piece of zinc, and here is the copper which is growing. Of course, you see only the shadow of the copper and the zinc in this instance, and hence the things appear black. This is not really black: it is red copper that you are looking at; but the shadow, of course, is black. You see these crystals that have grown out in various ways. Here is a piece of crystalline copper. See the graceful forms into which it has grown! Here are great masses of copper which have formed at the end of it, and which have stopped the progress, as they generally do. Well, here are little bubbles, there is the deep-coloured chloride of copper, and here are the crystals going into it, and there are the bubbles which are being formed. These are two substantial crystals of copper that are formed very like, in shape, the native metal that we get from Canada and elsewhere. I am sorry that I cannot show you the copper growing, but we will show you some of the copper which has been formed. We will take another metal. Instead of zinc and copper we will take zinc and tin. The tin is deposited much more rapidly than copper is, and hence we can see it being deposited before our eyes, and we can see it growing. Here is some copper, and you perceive that this, which was just a plain piece of zinc beforehand, has these little branches growing about it. Bubbles are forming at the same time. You see how it is growing in various ways. I can see that these are actually growing out, and that there are currents being formed of various sorts. These are certainly much larger and longer than when it was first placed upon the screen; but still, I will try to show it with tin much more rapidly. You see the crystals shooting forth—very beautiful points darting forward in the liquid. These are crystals of tin which are being formed upon the zinc, just in the same way as the copper, of which I was speaking just now. You perceive they are gradually growing and pushing their way into the liquid. Let us try some other parts of the liquid—try the other side, and see how they are growing there. Look at this thread. It is growing gradually, and becoming thicker and thicker, with fresh crystals being deposited upon it. I will call your attention to the formation of bubbles here. This, of itself, made a start, just now, and pushed aside some of the crystals which were growing upon it. This is the thin thread of tin to which I alluded just now, and you see how it has grown and shot out this large vegetation of tin at the side of it. You perceive, therefore, this beautiful natural growth of the metals round about the tin while the tin is displacing the metals from their solution.

This, so far, then, will illustrate to you that zinc is capable of turning out other metals from their solution, or, as we say, it has a greater affinity for the acid than these metals, for it dissolves away in the acid, and these metals remain. Now, suppose I were to take some sheet zinc, which I have here. I will take a piece of it and straighten it out. Now we will put that into a solution of sulphate of copper. I do not know whether we shall see it best by gas-light or by daylight. Perhaps the daylight will do it best. As I put this into the blue sulphate of copper, you see at once that this bright zinc is losing its lustre. It is becoming grey against the copper; and as it goes down further you perceive that this portion which has been longest immersed becomes very black, and bubbles arise at the same time. The zinc is becoming covered with a black deposit, and is no longer bright. A black deposit of copper is being formed upon it. Now we will allow that to go on before your eyes, and you perceive that it passes through a greyish colour into this black colour. This black deposit is metallic copper, though perhaps you are not accustomed to think of metallic copper as black. We generally think of it as red; but still its colour depends upon its state of division and upon circumstances. I do not know why it is, but I think I may fairly say that every metal, if formed sufficiently slowly, and in sufficiently fine crystals, appears perfectly black; and this copper upon the zinc, as we make it for our zinc couple, appears of a velvety black, or nearly as black as velvet, which is the blackest of all blacks. We will allow that to go on. It is gradually progressing, and now the black copper is deposited upon the zinc. It is what we saw magnified on the screen just now; that is to say, there are myriads of crystals of copper—similar crystals to those which I magnified. I purposely made the largest crystals I could; but there are myriads of crystals of copper all over the surface of this zinc, touching it at a great number of points and covering it with a film; so that if we put it into water, or into any liquid, the liquid will wet it all over, and get all among the crystals of copper to the zinc. We will allow this to remain until the end of the lecture, and I should not wonder if by that time the zinc removes all the blue copper from the liquid.

The way in which we make this couple, then, is to take a quantity of this zinc foil and to pour upon it some sulphate of copper. The sulphate of copper deposits this black covering upon the surface, and then we have what we want. It has to be washed and dried. Generally speaking, we wash it by means of alcohol, and afterwards by means of ether. We dry it in the way which Mr. Williams will kindly show to us now. Ether is poured from that little vessel, and then we have to get rid of the last traces of the ether. We dry it by warming it. You are aware that ether is a very volatile substance, and it cannot be heated without very soon going away altogether, and we warm it in an atmosphere of carbonic acid gas. If we begin to warm it, we first of all see whether the ether is really going off, and then we light it in this way. [The jet of ether vapour which issued from the vessel in which the couple was being dried was ignited.] We can see when there is no more ether left by its ceasing to burn. Now, during this time we are, of course, removing any extraneous substance. You recollect that the sulphate of zinc has already been washed away from the couple, and this is just to remove the last trace of water or of alcohol that may be employed.

Suppose we have now driven off the whole of the ether. Here is carbonic acid being produced, and it is bubbling through there in order to get dried, because we must use dry gas. The dry carbonic acid is bubbling through there and it is taking the place of the ether. The ether is very nearly driven off now; and if we go on heating it more we shall presently find that a change takes place. At present a change takes place, although there is not a great deal either of zinc or copper in that bottle. We can reduce its bulk by heating it, and then at a certain temperature the zinc becomes exceedingly brittle, and falls down to the bottom. All this time dry carbonic acid is passing through. You see now that the metal is reduced considerably in bulk, because some of it has broken down into powder; and we can use this powder as we wish, and weigh it out as we want it. [A portion of the powder was removed from the flask.] There, you perceive, is the most intimate mixture of zinc and copper which one can well conceive. This is our zinc couple, and it is prepared to act upon any substance—prepared to act like the zinc and copper plates, only there the copper and zinc is at about the distance of ten inches. Here they are touching one another—touching one another at myriads of points. There the zinc and copper had to be brought into connection one with the other by means of another piece of metal, while here they are already in connection with one another. They are touching one another, and the liquid is touching them, so that instead of having one large cell with a large amount of resistance, we have a cell in which the resistance is reduced to an infinitesimal quantity, because the liquid completely seizes the two metals—touches them at every point, and touches them at the points that are most important—the point of junction between the two metals in every direction. Hence the power of the two metals, whatever we call it: and chemists call it the chemical power, or we may call it the electro-motive power. Whatever power it may be, it is exerted at the best possible advantage.

We may now take substances like water or chloroform, which offer a very great resistance, and, by using this metallic powder, tear them asunder better than with all the batteries that can be invented—better than by all the galvanic apparatus which are in this institution, or in any of the institutions in London.

(To be continued.)

ON PHENOMENA PRODUCED IN LIQUIDS BY ELECTRIC CURRENTS OF HIGH POTENTIAL.*

By M. GASTON PLANTÉ.

THE author studied, with facility, the phenomena he now explains, by means of his secondary battery; whereas various *savants* (among whom were Davy, Grove, De la Rive, &c.), by using ordinary batteries, instead of a very high potential one, gave no satisfactory analysis to their investigations. He says: "By following the passage of currents of variable potential into liquids, we assist, so to speak, in the struggle between the electric flow and the two forces (molecular and chemical) which tend to maintain entire the metallic molecules of the electrodes, or the elements of the liquid body contained in the voltameter. If the electric flow possess a high potential, the mechanical and calorific effects dominate, the molecular attraction is overcome first, the electrodes are disaggregated, melted, or volatilised. If the potential is somewhat less, the electrodes form the seat of luminous phenomena, produced by the space and the rarefied vapours surrounding them; the liquid, scarcely wetting the electrodes, is only decomposed with difficulty. Let the potential still further decrease, and the principal calorific and luminous phenomena disappear, whilst chemical decomposition becomes manifested; and as, on the other hand, the current then traverses the liquid in a more complete manner, its strength will seem to be greater." Experiments were carried on with discharges from two secondary batteries—each composed of twenty lead plate couples—into a voltameter, containing a solution of diluted sulphuric acid. Various effects were produced, according to which pole was first plunged into the liquid, thus:—

1. Plunge the positive platinum electrode into the voltameter. Let a piece of exposed platinum wire also form part of the external circuit, to show, by its appearance, the varying resistance of the circuit. Then plunge into the liquid the negative pole of the battery; around it a shield of light appears, without sensible disengagement of gas. The platinum wire in the air does not redden; but in two or three minutes it becomes incandescent, the luminous sheath disappears, and an abundant release of gas takes place at both poles.

2. With a series of ten secondary batteries, whose discharge was equal to that from 300 Bunsen's elements, in potential series, the same experiment was performed. On immersion of the negative pole, its fusion or volatilisation took place with a kind of explosion, and a flame diversely coloured, according to the metal employed. If the liquid contained but small traces of acid, so as to prevent the complete fusion of the metal, a continued series of sparks, accompanied with a crackling noise (analogous to that from induction instruments) was produced, and these sparks were lengthened for several minutes, by gradually decreasing the current's strength.

3. The most important phenomena arose from using a mixture of chloride of sodium. On immersing the *negative* pole first, to a depth of 1 millimetre, and on bringing the *positive* pole into contact with the liquid, a small luminous globe, of perfect sphericity, was observed around the positive pole, with a noise. On lifting the wire, the globule increased to nearly 1 centimetre in diameter; by deeper immersion, a rapid gyratory movement ensued, and when it had acquired a certain speed, it detached itself, as though attracted by the other electrode, its disappearance being accompanied with an explosion and a flame at the negative pole. The globe the author considers not to be gaseous, because the conditions of the experiment were not favourable to the decomposition of water. He considers it to be a liquid globule, in a particular spheroidal state, illuminated by the electricity it encloses.

4. Instead of plunging the wire into the middle of the liquid, let it approach the glass sides of the voltameter. A luminous eddy is produced, and a brilliant furrow, of a sinuous or rounded zigzag form, winds hither and thither around the electrode, to a distance of 3 or 4 centimetres. Should it reach the neighbourhood of the negative electrode it occasions an explosion, or a noisy spark with flame, as before. The lesson sought to be taught from these phenomena is that these luminous globules, charged with electricity, animated by a revolving movement, producing a zigzag furrow, and dispersing themselves with an explosion or noisy spark, present a reduced image of globular-lightning, or thunderbolts.

* Abstracted from *Les Mondes.*

THE DIRECT UNITED STATES CABLE.

THE following condensed history of the actual laying and attempts to lay the Direct United States Cable will be of interest for future reference. We take it from the New York *Telegrapher*.

On the 16th of May, 1874, the steamship *Faraday* left the Thames for the United States to lay the New Hampshire and Nova Scotia section of the cable. Owing to foggy weather, the laying of this part was not completed until the 15th of July. The *Faraday* then proceeded to Nova Scotia for the purpose of submerging the main cable to a point on the coast of Newfoundland. On the

26th of July the cable had been laid from Nova Scotia to this point and was buoyed in Conception Bay. The *Faraday* then returned to England to take on board the remaining portion of the cable. On the 20th of August the *Dacia* landed the Irish shore end of the main cable in Ballinskelligs Bay, Ireland, and on the 2nd of September the *Faraday* effected the splice between the shore end and the deep sea cable, and commenced paying out toward Newfoundland. On the 4th of September, a fault having been discovered, the cable was hauled back, but parted during the operation. The cable was recovered, however, on the 6th, and the laying was proceeded with until the 10th, when the cable again broke while being taken back for a fault. After many unsuccessful attempts at grappling, owing to the tempestuous weather, the ships returned to Queenstown harbour on the 2nd of October for the purpose of re-fitting and taking in coal and supplies, and proceeded again to sea on the 23rd of the same month. On the 2nd of November the cable was picked up and spliced, and paying out was resumed toward Newfoundland. The laying was continued until the 8th of November, when another fault was observed, und the cable was cut and attempted to be buoyed. This, however, owing to the heavy sea, failed; and, as the weather showed no signs of moderating, the ships made for Harbour Grace, N.F. After a short delay, they proceeded again to the grappling-ground, where they arrived on the 16th of November. On the 24th, after the cable had twice been lifted and again abandoned on account of the severity of the weather, the cable was brought up and eight miles of it taken back. The fault was found to be in these eight miles. Bad weather, however, still prevailing, the cable had to be buoyed, and on being taken up again on the 25th it parted while being raised to the surface.

After several attempts to recover the cable, which were frustrated by the severity of the weather, the ships, running short of coal, put into St. John's, N.F., on the 7th of December, and left again on the 15th. The *Faraday* now took up the Newfoundland end of the Nova Scotia and Newfoundland section, made a splice, and, after laying the shore end and intermediate sections towards Ireland, again proceeded to grapple for the other end on the 19th of December. The weather, however, became so violent that, after the ships had kept to their work until the 9th of January, 1875, they were obliged to return to England for repairs and new stores. About two months ago, the *Faraday* returned and completed the task which had been beset with so many cares and difficulties.

By the laying of this cable, we have now five cables connecting the North American continent with Europe, as follows:—

Years.		Length.
1866	Ireland to Newfoundland	1896
1869	Brest to Duxbury, Mass., *via* St. Pierre	3330
1873	Valentia to Newfoundland	1900
1874	" " "	1900
1875	Direct cable	3060

The new cable is laid from Ireland to Nova Scotia, and thence to Rye Beach, New Hampshire.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Thursday, June 26, 1875.

Professor G. C. Foster, Vice-President, in the Chair.

The Earl of Rosse, Mr. L. Schwendler, and Mr. R. S. Brough were elected members of the Society.

Mr. W. J. Wilson read a paper on "*A Method of Measuring Electrical Resistance of Liquids.*" Great difficulty has hitherto been experienced in measuring the resistance of electrolytes on account of the polarisation of the electrodes, and most of the methods hitherto employed have aimed at reducing this to a minimum by using large electrodes and very weak or rapidly alternating currents. The determinations, however, are difficult and require to be quickly performed. The following method is easy and is free from both the above objections. The arrangement in its most simple form consists of a long narrow trough filled with the liquid to be measured, say dilute acid. A porous pot containing a zinc plate in sulphate of zinc being placed in the acid at one end of the trough, and a similar pot with a copper plate in sulphate of copper in the acid at the other end; the whole arrangement forms a sort of elongated Daniell's cell, the chief resistance of which is in the long column of acid. The circuit between the plates being completed through a resistance-box and mirror galvanometer, the current is shunted until a suitable deflection is obtained. One of the porous pots is now moved along the trough towards the other, and, as the resistance of the circuit is thus reduced by shortening the column of acid, the galvanometer deflection largely increases. The external resistance is now increased by means of the box until the deflection is reduced to the same point as at first. This resistance put into the circuit is evidently equal to that of the liquid taken out, and thus a measure of the liquid resistance is obtained. Two forms of apparatus were shown. In one, the vessels, containing sulphate of zinc and sulphate of copper respectively, formed pistons in a glass tube which contained the liquid to be examined. In the other, two pairs of concentric vessels were connected by a bent glass tube which contained the liquid under examination. The method is applicable to a great variety of liquids, and with care almost any degree of accuracy may be obtained. The chief obstacle to exact measurements lies in the fact that the resistance of liquids is greatly affected by temperature, but this difficulty is, of course, common to all methods. Mr. Wilson has been experimenting with brine and gave some of the results obtained, but he has not as yet made a sufficient number of experiments to complete a table. A mode of arranging the apparatus in a differential or bridge form was also described, but it has not been found necessary to use it; the simple circuit arrangement giving accurate results with less trouble.

Prof. Foster asked whether experiments had been made in order to compare this method with Wheatstone's, which differed from Mr. Wilson's as *liquid* electrodes were not used. He then described an arrangement he had adopted for measuring the polarisation of plates in a voltameter.

Prof. McLeod stated that he had used plates of amalgamated zinc and reversed currents to overcome polarisation. He found that some salts, chloride of zinc for instance, had points of maximum conductivity which corresponded to a definite degree of concentration.

Prof. Guthrie considered the research to be interesting as showing that points of minimum resistance might coincide with points of definite hydration of the salts.

Mr. Wilson, replying to Prof. Foster, stated that the chief objection to the use of metal plates is not a variation of the electromotive force of polarisation, but is due to the accumulation of bubbles of gas on the metallic surfaces.

Dr. Stone made a communication "*On Subjective Sensations of Taste.*" He drew attention to two simple experiments. The first consisted in applying a strong dilution of nitric acid to the root of the tongue by sucking it through a fine glass tube. If simple water were swallowed directly after this, a powerful sweet taste was felt. The same occurred if the acid were simply sipped; though not so quickly, from the time required to remove the acid from among the papillæ. He compared this effect to the complementary images seen in the eye after gazing at a powerfully illuminated body.

He then adverted to the taste of the galvanic current. In the well-known experiment with pieces of zinc and silver, it seemed zinc was actually dissolved in the saliva.

But, if the pole of a strong battery (ten Grove's cells in this case) were applied to the nape of the neck, and the other to the forehead, besides the well-known flash of light, a powerful taste was experienced of a metallic character. It disappears on breaking contact; and for this reason, as well as from the fact that the tongue is not in the direct line of circuit, and also that there is no substance in the saliva likely, by decomposition, to cause metallic deposition, it could hardly be referred to chemical action, but must result from direct stimulation of the sensory apparatus. He thought a glimpse might thus be obtained of some correlation between the *modus operandi* of hearing and sight and that of taste. In the first case, a supplementary and automatic sensation, in the second the effect of a metallic solution, both entirely subjective, were excited, without the presence of any vapid substance. It seemed possible that both were due to molecular motion, as, indeed, had long ago been held with regard to smell; and that, perhaps, ultimately all the intermediate senses might be found to occupy positions in the gamut of vibration between the last cognisable by the ear and the first by the eye, or rather by the touch in the form of heat.

Mr. Roberts mentioned an instance in which sudden danger had been followed by the peculiar taste which results from the introduction of two coins into the mouth, to which allusion has already been made.

Professor Foster thanked Dr. Stone in the name of the Society, and expressed a hope that he would continue his suggestive and important experiments.

Four other communications were made, of which abstracts will be given in a future number.

NOTES.

The International Telegraph Congress now sitting at St. Petersburg has decided in favour of the retention of the twenty words message as the normal length of telegraphic despatches. Above that length additional words are to be counted by fives, instead of tens, as at present; and a twenty-five word message will be charged only five-sixths of the price of a thirty-word message. The franc has been adopted as the standard of value in framing the tariff, and the unit in international telegraph accounts. The British proposal that the base on which the tariff should be fixed shall be the number of letters in a word and not the syllables, was, according to the *Pall Mall Gazette*, privately communicated to the representatives. A resolution accepting this principle has been adopted by the Conference. Within the limits of Europe, five letters are equivalent to a word, and ten on transatlantic lines, or lines going beyond Europe. A resolution forbidding the artificial formation of compound words has also been adopted. The idea of using the whole word as a base for the charge is too much in favour of the Teutonic system of forming compound nouns by simply joining two or three in one, instead of connecting them by prepositions, as in French and other Latin tongues. Thus one of the commonest orders sent on the Continent, that for firewood, might be given by the one German word Brennholz, or by our own similar compound, whereas the Frenchman would have to pay for three in sending for his *bois de chauffage*. The leading representatives have been instructed that the question of the respect to be paid to lines of postal telegraphs in time of war must be left, as one more suited for strictly diplomatic dealing. The British Postal Telegraph Department is represented at the Conference by Mr. H. C. Fischer, the Controller of the Central Telegraph Station in London, and Mr. Allan E. Chambre, the Surveyor of the Private Wire Branch of the department. Col. Robinson, with Major Bateman, represent the Indian Telegraph department; Sir James Anderson and Mr. Lewis Wells (formerly of the Electric and International Telegraph Company), the Eastern Telegraph Company; Sir James Carmichael and Mr. S. M. Clare, the Submarine Company; Mr. Andrews, the Indo-European Company, and Mr. H. G. Erichsen, the Great Northern Company.

Several attempts have been made during the past two or three years, says the New York *Journal of the Telegraph*, to apply the "Duplex" to the Combination Printing Telegraph instruments. The results obtained show conclusively that the application could be made successfully, the principal objection to its practical use being the mutilation of the printed slips by "breaks" from the distant stations. This objection has been completely removed by an ingenious application of the "Quadruplex" system to the printing instruments, by means of which the receiver at either end of the line can at any time "break" his sender without in any manner interfering with or attracting the attention of the other two operators. This system has now been in practical operation on the New York and Boston circuit for two weeks, with eminently satisfactory results. The oldest and most experienced operators in the printing service express the opinion that with the new system their work is performed more easily and satisfactorily than by the ordinary method of single transmission.

From the same source we learn that Prof. T. Eggleston has made a long and systematic series of experimental investigations into M. Bastie's new process of tempering glass. The prospective value and importance of this discovery to telegraphic interests can scarcely be overestimated. Glass is very extensively used in telegraphy, mainly for line insulators and battery jars; and the loss by breakage in these two items alone, to a Company like the Western Union, amounts to a very large sum of money annually. By the aid of this new discovery the average insulation of the wires may be vastly improved; for not only will cracked and broken insulators become a rarity, but the form of the insulators themselves may be greatly modified with advantage. One great difficulty ha hitherto been, that the disposition of material best adapted to secure good insulation—that of a hollow cylinder of great length and small diameter—is most unfavourable in respect to mechanical strength, and for this reason we have hitherto been obliged to make a compromise in form, which materially reduces the electrical resistance of the insulator during rain. The new process of tempering the glass will afford great possibilities of improvement in this respect. There are also many minor applications of this substance that will suggest themselves from time to time,—for instance, as a substitute for rd rubber in the manufacture of electrical and telegraphi

apparatus. Further developments of the capabilities of this extraordinary discovery will be awaited with great interest.

ELECTRICAL SCIENCE IN FOREIGN JOURNALS.

(This column will be devoted to a list of Electrical Memoirs published in Foreign Journals. Those of importance will be either translated in full or given in abstract.)

Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, vol. lxxx., No. 21, May 31, 1875.

Rapidity of Magnetisation and Demagnetisation of Iron, Cast-iron, and Steel.—M. Deprez.—The tell-tale machine used in researches, of which the following are the results, will be fully described in a later number of this journal:—The pieces of iron in it composing the electro-magnet are removable, all the other pieces, such as coils, armature, style, &c., remaining intact, so as to give evidence of the influence of the metal composing the electro-magnet. "The metallic portion of the electro-magnets, which I placed successively in the magnetising helices, was formed of two cores 2 m.m. in diameter, and 13 m.m. long. The exciting coils contained 14 metres of wire 0·2 m.m. in diameter. The battery used consisted of one Bunsen element modified by M. Dulaurier. Lastly, the varieties of iron experimented upon were the ordinary iron of commerce, the soft iron of telegraphy, malleable and grey cast-iron, and drawn and tempered steel. The results obtained were quite unexpected for soft iron, ordinary iron, malleable cast-iron, and *even tempered steel*, as they gave almost precisely the same readings, viz.:—

	Second.
Duration of the phase of demagnetisation ..	0·00025
" " magnetisation (approximately)	0·00150

Grey cast-iron gave still better results, since duration of magnetisation was reduced to about $\frac{1}{1000}$th of a second." This last metal, therefore, is that which will enable us (according to the author) to attain the greatest possible rapidity in the transmission of signals.

No. 22, 1875.

On Rotatory Magnetic Polarisation. — Henry Becquerel.—It has been remarked that bodies endowed with strong refraction generally possess a great magnetic rotatory power; but numerous exceptions to this rule hinder the full acceptance of these two physical properties. Thinking that if bodies were slightly magnetic and very refracting, the influence of refraction might become convincing, and that it would be possible, under these conditions, to display a relation between refraction and magnetic rotation, a very powerful electro-magnet was made use of, through whose armatures was pierced a cylindrical hole following the line of the poles. The measure of the rotations was effected by means of one of Jellet's penumbra polariscopes. The sources of light were the mono-chromatic flames of sodium, of thallium, and the flame of lithium seen through red glass to eliminate the orange light. Several experiments were made, and tabulated in two tables. In one of them the substances chiefly comprised compounds of chlorine, phosphorus, sulphur, and carbon, and they present a regular increase of rotation for the same length of wave, in proportion as the index of refraction increases. The second table does not show the same feature of regularity; and this may be attributed either to effects of lamellar polarisation, as in the diamond and garnet, to the presence of magnetic bodies, or to unknown causes. May we not possibly account for these effects by allowing the magnetic rotation of the plane of polarisation to be due to an action of magnetism upon the inter-molecular ether, and that at the same time the molecules of the body influenced are magnetically polarised, so as to present poles of a contrary name to those of the magnet. These molecules will then be so many small magnets inverse to the magnet influencing them, and acting at very small distances upon the medium which transmits the luminous vibrations. The intensity of this action is eminently variable with different bodies; it may depend upon their specific magnetism, and upon the reciprocal distance of the molecules. It is thus possible to conceive that the inverse action of these molecules may considerably lessen the direct action of the magnet; and even if the body is very magnetic, and under suitable conditions, this molecular action may become predominant, displaying a negative rotation as is observed with certain salts of magnetic metals. *En resumé*, the experiments demonstrate that in bodies feebly magnetic and very refracting, which have not hitherto been studied, the increase of the magnetic rotatory power follows as a rule the increase in the index of refraction.

No. 23, 1875.

Report of the "Commission on Lightning Conductors" Relative to a New Arrangement for Powder Magazines.—The new arrangement refers to the proposition of constructing air-shafts so as to place powder rooms in communication with the exterior air. The question asked by the War Administration of France was whether these air-shafts were sources of danger, irrespective of the lightning conductors erected around the magazines according to established usage. The answer given by the gentlemen forming this commission is:—"If the War Administrator adopts for his new powder magazines ventilation chimneys, and arranges the system of conductors so that the superior extremity of the chimnies remain always largely included in the generally admitted zone of protection, the commission is of opinion *the existence of these chimnies will not become in times of storms a special cause of danger*. However, in certain circumstances when, by reason of the impossibility of reaching an underlying inexhaustible sheet of water, or of the necessity of seeking for water at a large distance by conductors too much exposed to risk of malicious accidents, it is found advisable to give up supplying a magazine with lightning conductors, then air-shafts will be an element of considerable danger—especially when, on account of atmospheric causes, their interior sides becoming damp. Under such circumstances they should never be built."

No. 24, 1875.

The number contains no papers on electrical science, being filled with the usual annual announcements of prizes.

Poggendorff's Annalen der Physik und der Chemie, No 3, 1875.

Contributions to Electro-dynamics.—M. Zöllner.—According to Ampère's law, the rotation in an electro-dynamic rotatory apparatus is due to forces exerted immediately by the magnet on the individual elements of the movable conductor; but Helmholtz represents it as due to forces exerted by the magnet on the particles of mercury, and then from these on the moving part, the seat of the action being thus only where the wire is in contact with mercury (the particles of the latter are put in rotation, and by adherence to the conductor carry it along with them). M. Zöllner sought to decide between these two views by experiment. He modified Faraday's experiment by shortening the arms of the horse-shoe wire and hanging from them chains which dipped in the mercury. If the impelling force be merely in the gliding part (*Gleitstelle, i.e.* where the chain and mercury are in contact), the chain should move in a certain direction, and pull the wire above after it. But the opposite occurs,

the bent wire moves round and drags the chain. Further, the chain should take a certain direction when the wire is held fast; but it does not. Helmholtz has thought to bring the experiment under his theory; M. Zöllner here adduces a number of other experiments supporting his view, and elucidating the mechanics of the gliding parts. These cannot well be described without the figures.

Relation of Temporary Magnetism to Magnetising Force, and its Bearings on the Reciprocal Action of Metallic Particles.—M. Börnstein.—The nature of the experiments was briefly this:—Fine powdered masses of the magnetic metals, chemically prepared, and mixed variously with argillaceous earth, were enclosed in glass tubes, corked at both ends, thus forming bars of various density, which could be thrust into and drawn out of a magnetising spiral. A small steel magnet with mirror, was hung a little way off the end of the coil, and above its level. The deflection by the coil was compensated by a simple circuit on the other side, which received the same current. The deflecting action of the magnetised bars was thus brought into prominence. Each bar was subjected to currents of different strength, and the residual magnetism examined. *Inter alia*, it appears that by mixing a non-magnetic substance with iron, the magnetic nature of nickel or cobalt may be imparted; and similarly, to nickel, the magnetic nature of cobalt (disregarding the absolute weight of the metal). The phenomena of temporary magnetism are affected in the same way, when one increases the dimensions in direction of the magnetising force at cost of the other dimensions, as they are when one separates the small particles of the magnet from each other. The metal diluted as described presents more favourable conditions for magnetisation than massive metal. Bars of different density show magnetism the differences of which decrease with increasing magnetisation, and, on saturation being reached, quite disappear. The entire reciprocal action decreases with increasing magnetisation. *En resume*, the course of magnetisation in soft magnetisable metallic bodies depends both on the form and the density of the magnet, and this dependence is to be explained by the reciprocal action of the magnetic molecules.

Transition Resistance (Uebergangs-widerstand) of Metallic Conductors.—M. F. Müller.—The author suspended a brass chain by a double hook from a mercury cup; it had a weight scale at the lower end, and another mercury cup, and was enclosed in a glass tube. The current sent through it had to pass sixteen points of contact. The slightest shaking was found to greatly alter the resistance; but this was remedied by first tapping several times on the support till the needle became stationary. Weights of 100 to 400 grms. were used, and it appeared that transition resistance is independent of the intensity and the electro-motive force. Its amount is extremely small, even if the conductors are in contact at one point with a pressure of 400 grms. The experiment was not adequate to show the dependence of transition resistance on the amount of pressure. In a binding screw a pressure of several kilogrammes may be produced (not to speak of the fact that the contact is not at a point, as in the chain, but in a line).

Specific Heats of the Elements, Carbon, Boron, and Silicium.—Dr. H. F. Weber.

On Unpolarisable Electrodes.—M. Oberbeck.—Du Bois Reymond discovered that amalgamated zinc plates show no polarisation in solutions of zinc salts; but no sufficient explanation has been given of this. From his own experiments M. Oberbeck infers that the property essentially depends on the peculiar behaviour of the mercury amalgam (requiring further study), and not on indifference of the electrodes to the separated gases, which rather call forth the same polarisation phenomena (qualitatively) as in the case of other metals being used. Their non-polarisability is thus only of a limited character.

Simple Way of Finding the Pole of a Bar Magnet.—M. F. Müller.—A magnetised sewing needle, between two pieces of cork, is floated horizontally on water, and allowed to place itself in the magnetic meridian. A pointed iron wire is brought down, in vertical position, towards one of the ends. The needle then shifts in position, till the resultant of all forces goes vertically through the iron wire. If the wire point be carefully brought closer till it touch the magnet, contact takes place at the point of strongest attraction. To mark this pole point, the point of the wire is previously dipped in oil paint. On repeating the experiment, the same point is always found.

Journal de Physique, May, 1875.

On Currents of Mechanical Origin.—M. Bouty.—The author has shown that the intensity I of a current, produced by expenditure of τ kilogrammetres per second, in a circuit of total resistance, R is represented by the formula

$$I = \sqrt{\frac{\tau}{R}}$$

Some of M. Rossetti's recent experiments with the Holtz machine seem in contradiction with this. M. Bouty seeks to prove that they are not really so. The mode of production of energy generating the current of the Holtz machine is quite different from that in batteries. In the latter, the charge produced per unit of electricity transported is constant, and this is why Ohm's law applies: in the former, the energy expended per unit of time is fixed, and Ohm's law has to be replaced by the formula above, along with another, viz., $\tau = \phi\ (I\nu) + RI^2$; $\phi\ (I\nu)$, being a function of the intensity of the current and the speed of rotation.

Determination of the Electric Capacity of Bodies, and Condensing Power, by means of Thomson's Electrometer.—M. Terquen.—The author describes improvements on Thomson's instrument by M. Branly; also M. Angot's method of using it for the purpose indicated.

The Electric Light in Rarefied Gases.—M. Daguenet.—He produces the Geissler-tube effects in the vacuum of a barometric tube, soldering a platinum wire at the upper part, and putting the other electrode in the mercury.

Note on a New Method for Finding Iron Ore, by Means of Magnetic Measurements, and Account of some Experiments on this Subject.—M. Thalen.—The method is adopted in Sweden, and M. Thalen employs the needle for ascertaining not only the existence, but the strength, general direction, and depth under the soil, of the masses of ore.

Researches on Interrupted and Interverted Currents, and their Thermal and Electrodynamic Effects.—M. Villari.—An iron wire is heated more by an interrupted current than by a constant one, and still more, if the direction be reversed at each interruption. The *augmented resistance* increases (M. Villari finds) with the thickness of the wire; also with the intensity of the current, but only to a certain limit. It further increases with the rapidity of the interruptions and the number of reversals per second.

Repertorium fur Experimental Physik,
Heft 1, 1875.

Determinations of Magnetic Declination in Russia.—Smirnow.

On the Electro-dynamic Torsion Balance.—A. Lallemand.

COMMERCIAL NOTES.

THE Manager of the Direct Spanish Telegraph Company (limited) has issued the following circular :—

"106, Cannon Street, London, E.C., 1st July, 1875.

"Sir,—Several shareholders having enquired the cause of the present low quotation of this Company's ordinary and preference shares, I am instructed by the board to state that they see no ground for such depreciation; on the contrary, they congratulate the shareholders on the satisfactory progress of the company's business. The accounts for the half-year ending 30th ultimo show profits sufficient to pay a dividend for the past half-year at the rate of five per cent. per annum on the ordinary shares, after providing all interest on preference shares up to that date. All quarterly balances up to 31st March last have been regularly received from the Spanish and French Governments. Both the Company's cables continue in excellent working order.—I am, Sir, your obedient servant, CHARLES GERHARDI, Manager."

The average receipts of the Anglo-American Telegraph Company during the first completed week of the month were £1150 per day; on the second week, £1193; and on the third week, £1256 per day. From the 1st of May the tariff has been reduced from 4s. to 2s. per word.

Interest on the shares of the Great Northern Telegraph Company at the rate of five per cent. per annum is payable this day, at the offices of Messrs. C. J. Hambro and Son.

The net profits of Reuter's Telegram Agency for the year ended December, after payment of current charges, were £6329 including £244 brought forward. The usual interim dividend of 2½ per cent. was paid in October, and a further dividend of 8s. per share is now recommended, making 7½ per cent. for the year.

An extraordinary fall occurring in the quotations of the stock of the Submarine Telegraph Company, the Secretary announced by circular that all the cables are in excellent working order, and the receipts much the same as in the corresponding half-year. He attributes the fall to the action of parties hostile to the Company, who are endeavouring to obtain possession of the stock for other purposes at a low price.

Speaking of the state of the Telegraph Share Market, the *Examiner* says—"Although the new cable to America is reported laid the shares have declined, which can only be regarded as extraordinary, considering that previous to the news of its total submersion the shares stood at about 2 higher than at present. Atlantic telegraphy may be profitable, and undoubtedly would be, were it not for the fact that so many people, as a rule, have a finger in the pie, and each wants a plum, and, moreover, generally gets it."

The Western Union Telegraph Company have declared their quarterly dividend of 2 per cent, payable on the 15th inst. The net earnings of this Company for the year ending June 30th, 1875, including the sum of 758,551·49 dols. brought forward from last year's income account, amount to 3,912,484·39 dols. (May and June estimated); and, after paying its interest on the bonded debt for the past year, amounting to 429,456 dols., and four quarterly dividends of 2 per cent each on its stock, including that payable on the 15th inst., there remains a balance to the credit of income account of 780,674 dols.

With the steamship *Professor Morse* the Cuba Submarine Telegraph Company are about to lay a duplicate cable between Punta Rassa and Key West.

At a recent meeting of the Eastern Extension, Australasia, and China Telegraph Company the extension of the system to New Zealand was approved, and the Directors were authorised to proceed with it, and also to enter into any agreement with the Government of New Zealand they might think advisable. An interim dividend for the quarter ending the 31st March of 3s. per share or 6 per cent per annum is payable on the 15th inst.

PATENTS.

ABSTRACTS OF SPECIFICATIONS.

Improvements in automatic chemical telegraphs, comprising transmitting and receiving instruments, circuits, and apparatus connected therewith, part of the said improvements being also applicable to other telegraphs. Alexander Melville Clark, patent agent, Chancery Lane, Middlesex. (A communication from William Edward Sawyer, Washington, Columbia.) November 26, 1874.—No. 4063. The present invention relates to a new and improved system of automatic chemical telegraphs, comprising transmitting and receiving instruments, circuits, and apparatus connected therewith.

Improvements in electric telegraphs. Sir James Anderson, Knight, and William Henry Ash, 66, Old Broad Street, London. November 27, 1874.—No. 4075. According to this Provisional Specification, in duplex working an electro-magnet or induction coil is put in circuit in the actual line. In single working, an electro-magnet is placed immediately after the sending key.

An improved mode or method of communicating between the guard of a train in motion and the station-master during the transit from station to station. George Pocknell, Exeter. November 28, 1874.—No. 4083. This consists in an arrangement of wires and stops close to the edge of the line or sleeper, said stops being acted upon by a spring from beneath. The guard's carriage is furnished with means for pressing down the stops, so as to break the current of electricity which passes up into carriage, and connected with electro-magnetic telegraphic apparatus.

Improvements in the method of, and apparatus for, signalling trains. John Clough, manager, Bradford, York. November 28, 1874.—No. 4086. Upon the track of railway is placed three insulated rods, to which are connected at intervals batteries from which currents are transmitted to engine or guard's van, by means of three wheels attached to the train and running upon the insulated rods. To these wheels wires are attached communicating with magnets on engine or guard's van. The alternate breaking of contact of these rods right and left enables the driver or guard to know that a train is or is not one mile (or the distance the batteries are apart) ahead of train in motion.

Improvements in telegraphic apparatus partly applicable to other purposes. Stephen Mitchell Yeates, optician, Grafton Street, Dublin. December 2, 1874.—No. 4141. These arrangements are applicable to indicate the position and movement in either direction of any axis at a distance.

Improvements in apparatus for signalling. John Thomas Gent, electrician, Leicester. December 14, 1874.—No. 4300. This invention consists in apparatus for signalling, composed of an electric bell and indicating tablet. The rising of a vertical sliding-rod liberates the indicating tablet, and shows the room or place from which the signal is sent, and at the same time closes the voltaic circuit of the electric bell and causes the bell to ring. The vertical sliding-rod may be raised by an elastic air-chamber underneath it. Compressed air being forced along a tube to the said air chamber, it expands, and raising the rod described, liberates the tablet and rings the bell. The ringing continues as long as the rod is raised. The raising of the rod may be effected by a wire instead of by compressed air.

TO CORRESPONDENTS.

⁎ Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which "THE ELECTRICAL NEWS and TELEGRAPHIC REPORTER" is the organ, will always command attention. Literary communications and books for review should be addressed to the EDITOR; business communications to the PUBLISHER, Boy Court, Ludgate Hill, London, E.C.

London: Printed and Published by the Proprietor, WILLIAM CROOKES, at the Office, Boy Court, Ludgate Hill, E.C.
July 1, 1875.

 [Registered for Transmission Abroad.

VOL. I. No. II.] JULY 8, 1875. [PRICE FOURPENCE.

THE

ELECTRICAL NEWS

AND

TELEGRAPHIC REPORTER.

Edited by WILLIAM CROOKES, F.R.S., &c.

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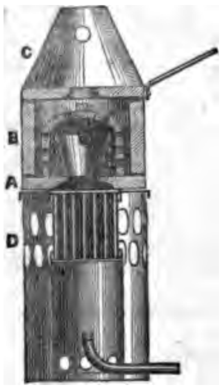
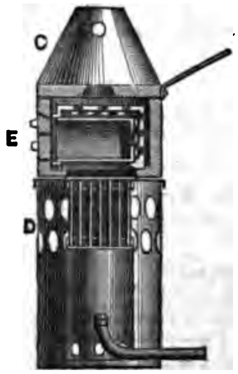
LONDON: BOY COURT, LUDGATE HILL, E.C.

1875.

FLETCHER'S NEW UNIVERSAL FURNACE

(GAS),





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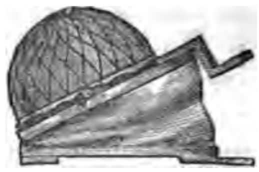

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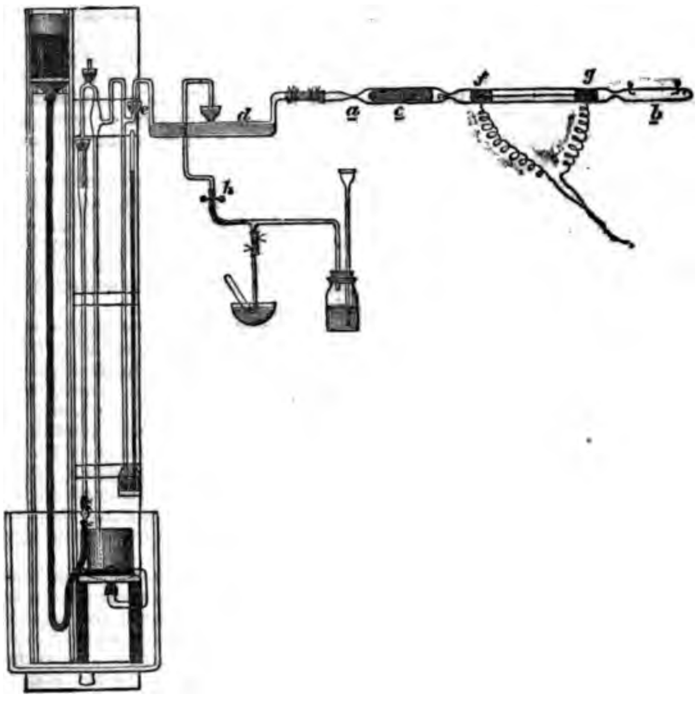
THE ELECTRICAL NEWS.

VOL. I. No. 3.

ON A VACUUM WHICH WILL NOT CONDUCT ELECTRICITY.

By WILLIAM CROOKES, F.R.S., &c.

I HAVE thought that a description of the apparatus which I fitted up in the course of my researches on Attraction and Repulsion* for the purpose of preparing a vacuum which would not carry a current from a Ruhmkorff coil might, perhaps, be useful to some of the readers of this journal. Neither the best vacuum my air-pump would give nor the ordinary vacuum produced by the Sprengel pump were sufficiently good for my experiments. I could prepare a vacuum with my Sprengel pump which would hardly allow an induction current to traverse it, or would only show a faint cloud-like discharge; but it was impossible to effect this in the large tubes I required for my experiments. I therefore fitted up the apparatus shown in the woodcut, and by this means I proved that in a chemical vacuum, which will not carry an induction current, the repulsion by radiation is decided and energetic.



a b is the tube containing a straw beam with pith ball terminals; at *b* two platinum wires are passed through, to connect with an induction coil; at *a* the tube is contracted to allow the apparatus to be sealed off; *c* is a portion of the tube containing a copper boat filled with freshly cast sticks of caustic potash; *d* is a tube bent as shown, and nearly full of strong sulphuric acid, which has been previously boiled for some minutes and then allowed to cool in a vacuum; *e* is a mercury joint, connecting the apparatus to the Sprengel pump. At the upper part of the tube *d* is a stopper fitted into a funnel joint and capable of being replaced (as shown in figure) by a tube through which I could pass carbonic acid when desirable. The carbonic acid was prepared by the action of hydrochloric acid on marble; when not being passed into the exhausted tube, the gas was kept bubbling through mercury, where a tube full could be collected from time to time (as shown in figure) to test with potash. It was found necessary to keep the evolution going on all the time pretty briskly, to prevent air diffusing in. The joints were made of double caoutchouc tubing, the smaller one tightly wired on and coated with glycerine before the larger tube was slipped over it. The whole was then tightly bound with wire. To prevent air creeping down between the mercury and the glass, glycerine was poured over all the mercury joints, except the one at the top of the mercury fall-tube, which was kept for oil of vitriol, with which the pump was lubricated from time to time.

The apparatus being exhausted of air, the balance was adjusted by heating the ends so as to slightly char the one which happened to be the lower. *f* and *g* are two collars of silver foil encircling the tube where the heat is to be applied, and connected with earth by wire. At a very high rarefaction the flame of a spirit-lamp excites so much electrical disturbance in the balance that its adjustment becomes well nigh impossible. This arrangement was adopted in the endeavour to carry off the electricity; it is, however, only partially successful, and the electrification of the balance at the highest rarefactions is still very troublesome.

The air having been moved from the apparatus as perfectly as the Sprengel pump would effect it, carbonic acid was let into the tube by cautiously opening the tap *h*. Exhaustion was again effected, and carbonic acid passed in a second time. This was then pumped out, and the apparatus was filled a third time. This alternate filling with carbonic acid and exhaustion was continued until the gas collected at the bottom of the mercury fall-tube of the pump was entirely absorbed by potash. When

* "On Attraction and Repulsion resulting from Radiation." By William Crookes, F.R.S., &c. A paper read before the Royal Society, December 11, 1873.

this was found to be the case, the exhaustion was allowed to proceed to the highest possible point.* The pump was then stopped; an induction-current now being passed between the wires at the end *b* showed the usual white light of a carbonic-acid vacuum (a trace of red shows atmospheric nitrogen).

The sticks of potash in the copper boat in *c* were then heated to incipient fusion, and the whole was allowed to cool for some hours. The tube was then sealed off by applying a spirit-flame to the contracted part *a*; the potash was then heated again, and the whole was set aside to give the potash time to absorb the residual carbonic acid.

By testing from time to time with an induction coil, the progress of the absorption could be traced; and when the current ceased to pass through the tube, but preferred to strike across in air the full length of the spark, the vacuum was considered nearly perfect. Warming the potash with a spirit-flame, at any time, will cause it to give off sufficient aqueous vapour to allow the spark to pass as a cloud-like luminosity. This will be gradually absorbed until, in the course of from a few days to a few weeks, the vacuum will again cease to conduct.

I have called this a *chemical* vacuum, because I object to the word *perfect* as applied to any vacuum at present known; for where force can travel, we are not, I maintain, justified in assuming the absence of matter —imponderable it may be, and unaffected by ordinary forms of force—but none the less matter.

* When the pump is working in a very good vacuum, the friction of the falling mercury produces a very beautiful effect in the dark. Brilliant points of light flash about wherever the mercury-drops are splashed from side to side, and the pump is frequently illuminated with a phosphorescent glow filling all the tubes.

STUDIES ON FRICTIONAL ELECTRICITY.

In his comparison of frictional with galvanic electricity, Gauss observed this difference among others, that while the latter obeyed Ohm's law, the strength varying with the resistance, the current of the electric machine remained constant, however great the resistance presented by the body through which it flowed. Poggendorff, too, apparently verified this for the Holz machine. Gauss sought to explain the difference by a difference in the development of the current, which, in the case of the electric machine, depended exclusively on the working of the machine; whereas, in all other electromotors, the quantity of electricity depends on the resistance, the electromotive force remaining the same.

In a recent interesting paper by M. Francesco Rossetti, not only the explanation, but the phenomenon itself, is questioned; though, in his first experiments, this Italian observer got the same deflection of the galvanometer, whether he let the current (of the machine) go direct into the galvanometer wire, or made it pass, first, through a resistance of 10,000 Siemens units. We will try to give a brief outline of his argument.

Gauss's explanation would be correct if the quantity of electricity which the machine furnished at each turn were the same; which would certainly be the case if the rubbing body and the rubbed were not in the least influenced by a greater or less resistance of the wire connecting them. But it is very probable there is such an influence, though it may have escaped Gauss's and Poggendorff's observation.

Compare a hydrogalvanic-electromotor with a friction electromotor. The galvanic current depends on chemical action or work in the battery; and it has to overcome the resistance in parts outside of the battery as well as that of the battery itself. Ohm's law says that the strength is directly proportional to the electromotive force of the battery, and inversely as the entire resistance of the circuit. Hence, when the entire resistance is increased by increase of the resistance of the outer circuit, the strength is diminished correspondingly; and at the same time the internal work of the battery diminishes in like proportion.

In the friction electromotor, the current depends on the work expended in rotating the rubbed body. Of this work part is lost in shocks and shakings of the apparatus, or is changed into heat, and the rest is transformed into electricity. This remainder represents the internal work of the electromotor, and the strength of the current must be proportional to this internal work; as, in the voltaic battery, the strength is proportional to the internal chemical work.

And similarly, too, there must be an internal resistance in the friction electromotor, and the current developed must overcome the whole resistance, consisting of the internal, and of that presented by the conducting substance which connects the substances rubbed together.

Ohm's formula should, therefore, be found applicable also to these currents, if account be only taken of the internal resistance in the electromotor. And in the application we must always bear in mind that the electromotive force and the internal resistance may and must vary with changes of the velocity of rotation and of the moisture of the air; whereas, in the case of a given voltaic battery, these two values remain pretty constant.

If Ohm's formula apply to friction electromotors, the following are consequences:—

1. If we arrange two experiments, with equal velocity of rotation, and with a small external resistance in the one, a large in the other, the strength in the former case must be greater. If Gauss and Poggendorff found no such difference, this may only show that the resistances introduced were too small in comparison with the internal resistance. If a sufficiently great resistance be placed in the external circuit to be comparable with the internal, we must have a diminution of strength in the current, and a change of work applied in its production (which portion of the work requires special measurement).

2. If we repeat the experiment with different lengths of the external circuit, and wish to obtain an equal strength of current in both cases, it will be necessary to increase the velocity of rotation in the second case; the electromotive force must be increased in proportion as the resistance is increased, and this we can do by rotating more rapidly.

3. If, instead of rotating the machine with the hand, we use machinery worked by a falling weight, it should be observed that, if the resistance of the exterior circuit be successively increased, the strength of the current is gradually diminished, and the mechanism accommodates itself to the new conditions of increased resistance; so that the velocity of rotation becomes smaller, and the space fallen through by the weight less, as also the dynamical worked expended; just as the strength of the current and the internal chemical work of a voltaic battery become less on increasing the resistance of the circuit.

M. Rossetti made a great number of experiments by way of testing these theoretical results. It was of consequence (1) to measure the rotation accurately; (2) to determine the work consumed in unit of time, in putting the electromotor in action, after deduction of that part of the work which served other ends; (3) to measure the strength of the current produced by a given velocity of rotation; (4) to ascertain exactly the resistance and electromotive force which the electromotor possessed when it produced a current of given strength with a given velocity of rotation. This requires that one be able to introduce a resistance into the exterior circuit, which will be comparable with the internal resistance. Lastly, the moisture of the surrounding air must be determined, in order that experiments on different days might be compared with each other.

The instruments used were—a Holz machine; a rotation apparatus, moved by a falling weight; a counter for

the number of rotations: a galvanometer; a rheostat, of tubes containing distilled water; a hair hygrometer; and a chronometer. With regard to the manner of the experiments, we will only observe that the measurement of the work expended in production of electricity was done by first determining, with the falling weight, the work required to produce a given rotation when the machine was not charged (and, therefore, no electricity developed); then determining the greater work necessary to produce the same velocity of rotation, when the machine was charged and electricity developed; the difference was the quantity desired. For additional details we must refer to the original memoir. M. Rossetti gives the following as his results:—

1. In the same series of experiments (with the same degree of moisture), the strength of the current produced by the electromotor is nearly, but not quite, proportional to the velocity of the disc.

2. The proportion between velocity of the disc and strength of the current varies considerably with the moisture of the air, increasing with its increase; *i.e.*, the number of turns which the disc must make each second, so as to produce a current of given strength, is greater on damp days than on dry.

3. The actual work (which serves to put the electromotor in action) expended in each unit of time is exactly proportional to the strength of the current, provided the experiments are made in air with the same degree of moisture.

4. The proportion between the expended work and the strength of the current decreases with increasing moisture; so that, to obtain a current of given strength on a damp day, a greater velocity of rotation indeed is required, but, on the other hand, less work is expended. The electromotor is thus more economical on damp days than on dry.

5. Using the rotation apparatus, if we denote as total motive weight the weight which imparts a given velocity when the electromotor is charged,—partial motive weight, that necessary to give the same velocity when electromotor is uncharged—and effective motive weight the difference between these two; then, in the same series of experiments, the effective motive weight continues nearly constant, whatever the amount of the total motive weight.

6. The effective motive weight varies with variation of the amount of moisture in the neighbourhood; it is greater on dry days, less on damp days.

7. The distance between the two discs, and that between the armature and the movable disc have also an influence on the effect of the electromotor. If the distance increases, the strength of the current decreases, and also the dynamical work expended in its development.

8. The Holz electromotor behaves similarly to the voltaic battery; like this, it has a determinate electromotive force and an internal resistance; both of which are constant so long as the velocity of rotation and the degree of moisture of the air are unchanged, but with change of one or other of the latter, one or other of the former is also changed.

9. The electromotive force of the Holz machine remains constant whatever the velocity of rotation, provided that the state of moisture remains constant.

10. The electromotive force alters with variation of the state of moisture in such a way, that with increasing moisture it decreases.

11. The internal resistance of the electromotor remains constant, with the same velocity of rotation, whatever the state of moisture.

12. It varies with change of the velocity in such a way, that with increasing velocity it decreases, and the values of this resistance decrease in faster ratio than the increase of the velocity.

13. The effective motive weights may be considered as directly proportional to the electromotive forces.

14. In the Holz electromotors, the electromotive forces corresponding to the different degrees of moisture are very great in comparison with the electromotive forces of the more energetic voltaic batteries. With the relative degree of moisture 0·69 we have the electromotive force E = 433000 Siemens × Weber units, and with the relative moisture 0·35 E = 599000; whereas for the Daniell battery, E = 11·57, and for the Grove, E = 19·98. The greatest electromotive force of the Holz machine is thus 51,860 times greater than that of the Daniell battery, and 30,030 times greater than that of the Grove.

15. The internal resistances of the Holz electromotors, corresponding to different velocities, are enormously large. The smallest internal resistance, which corresponds to the velocity of 8 rotations in the second, is equal to 570 million Siemens units, while the velocity of 2 rotations per second corresponds to a resistance of 2180 million Siemens units.

16. The currents of electric machines obey Ohm's law, like the currents produced by other electromotors. When, therefore, resistances are inserted in the external circuit, which are not to be neglected in comparison with the enormous internal resistance of the electromotor, there must occur a decrease of strength in the current, in accordance with Ohm's law. (This decrease was rendered very evident, by using the rheostat with distilled water.)

17. When the disc is driven by a rotation apparatus actuated by a falling weight, it is observed that, with successive increase of the external resistance, the strength of the current progressively diminishes, and the mechanism accommodates itself to the altered conditions of increased resistance; so that the velocity of rotation diminishes, and therewith is diminished the extent of fall of the weight, and the dynamic work expended becomes gradually smaller, just as in the voltaic battery.

18. If the actual work expended in unit time in each experiment be divided by the total heat which the current produced by it would be capable of producing at the same time (reckoning this heat according to Joule's formula), a nearly constant number is obtained; the mean of 17 experiments gave the number 428, almost identical with 425, the number generally received as expressing the mechanical equivalent of heat.

THE DISTRIBUTION OF MAGNETISM IN A THIN PLATE OF GREAT LENGTH.

By JULES JAMIN.

(Concluded from page 16).

WHEN we measure, by trial of contact, the *wresting force* of any point, we measure a complex effect; for this "contact" attracts not only by the magnetism which is upon the point covered, but also by a portion of that which is spread over the neighbouring points; and this action extends further in proportion as the magnetic conductibility of the steel is greater. The measured intensity y_1 then is equal to the intensity y found for a conductibility equal to the unit multiplied by a function of k.

$$y_1 = y\,f\,(k).$$

This function will be determined by-and-bye. Now since the conductibility of the same piece of steel increases with the annealing process to which it has been subjected, the values of y should augment.

As k_1 expresses the relation of two intensities y_1 observed at points on the same steel separated by the unit distance, it is independent of $f\,(k)$ and measures the relation of the true intensities y. Such is not the case with the intensity A_1. That is equal to $A\,f\,(k)$ if we designate by A the true ordinate, and it may be that the increment of A_1, under the action of the anneal, proceeds wholly from the increase of conductibility. To settle the

question it is necessary to employ a measuring method independent of this cause of variation.

I chose that method proposed by Van Rees in 1849. It consists in inserting the magnet into a very short coil of conducting wires united to a galvanometer; to rapidly move the coil from x to x', and measure the deflection produced by the induction current. According to Faraday and Lenz, this deflection depends simply on the lines of magnetic force intersected by the coil, and which are bounded by x and x'; it is thus proportional to the quantity of magnetism comprised between x and x', and is independent of the form of the coil provided the latter be sufficiently tight against the steel. M. Gaugain adopted this plan without modification. Recently M. Blondlot rigorously proved that Van Rees method is only exact for a single case; that in which the magnet is very long and the coil is rapidly transferred first from the middle line to its extremity, and thence to an infinite distance. In this case the deflection measures M the whole of the magnetisation. These values, M, are given in the third column of the table.*

On the other hand, let us call A the true value of the ordinate at the commencement; we shall obtain a second valuation of the total magnetism by integrating the expression $y\,d\,x$ from zero to infinity; and, as this valuation will not be related to the same unit as the preceding one, we will express it by the product of M with a constant a

$$Ma = \int_0^\infty Ak^{-x}\,d\,x = \frac{A}{l.k}$$

whence

$$\frac{A}{a} = M\,l.\,k$$

The values of M log k are shown in the fourth column of the table, and are very sensibly constant. Hence it follows that the true value A of the ordinate at the commencement is constant for the same steel, whatever may be its degree of temper. The coefficient A_1, which had been found by the proof-plane method, is a function of the conductibility, and its increase by annealing proceeds only from increased conductibility.

We must now find the relation of A_1 to A or $f(k)$. I said that A_1 should be equal to $\frac{A}{k^2}$. Indeed, $\frac{1}{k}$ expresses the coefficient of conductibility in a lineal magnet, and $\frac{1}{k^2}$ will represent the superficial coefficient in all the directions around a point on the plane of a magnet; the observed intensity A_1 will be proportional to this coefficient and consequently equal to $\frac{A}{k^2}$. Whence $A = A_1 k^2$. We have already found this quantity to be constant, and we now see that it expresses the true ordinate at the extremity of the bar. Whence it follows that the expression for the true ordinate y at any point whatsoever will be

$$y = A_1 k^2 k^{-x} = A\,k^{-x}$$

that of the observed ordinate being

$$y_1 = A_1\,k^{-x} = A\,k^{-(x+2)}$$

To classify the steels in a magnetic point of view it will then be necessary to transform them into long plates with a thickness of one millimetre. Let A_1 and k be measured. $A_1\,k^2$ will be the true ordinate; it will represent the magnetic power of the steel; it will depend simply on the chemical composition of the steel; and it cannot be changed, neither by the process of annealing nor by temper.

The second constant k is at the disposition of the constructor; it augments by temper, and diminishes by the process of annealing.

The attractive force exercised at the extremity of the bar is proportional to y_1^2 whence $\left(\frac{A}{k^2}\right)^2$. For the same steel this force increases with the anneal, and diminishes with the temper.

The height of the true magnetic curve at the extremity of the bar is invariable and equal to A; but the measured height by "trial of contact" is $\frac{A}{k^2}$ and increases with process of annealing.

In proportion as k decreases by anneal the magnetic curve lengthens. The steel used should therefore be longer the more it is annealed; otherwise it cannot contain the whole of the magnetism it is capable of. Such was the case with No. 12 in the table.

The quantity of total magnetism $\frac{A}{l.k}$ increases with the anneal; the quantity measured by "trial of contact" increases more rapidly still and is $\frac{A}{k^2 l.k}$.

The conclusions to be learnt from these experiments and reasonings are that *to make magnets which shall exercise great* CONTACT-ACTIONS *we must use annealed steels of very great lengths; but if we desire* DISTANT-ACTIONS, *we must use short and strongly tempered steels.*

* See ELECTRICAL NEWS, No. 2, p. 16.

RAILWAY SIGNALS.

By J. DUTTON STEELE, C.E.

THE Committee on Railway Signals,* appointed at the Sixth Annual Convention of the American Society of Civil Engineers, to enquire into the various systems of signals in use upon the several railways of the United States, and to report at the next Annual Convention, with such recommendations as may seem important, report as follows:—

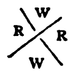
In treating the several kinds of signals as they are in use upon the roads in this country and in Europe, the Committee may find occasion to refer to several specific devices which have been brought to its notice; and in describing the American practice as we find it, it is not proposed to burden this report with the mass of detail which has been kindly furnished in response to the circulars, and which was necessary to an understanding of the subject, but to select a few of the most important roads covering the several systems, more with a view of showing the variety of practice than the merits of the cases described; in treating the audible signals not more than three notes, signifying "stop," "start" and "go back," shall be considered, as they are all that are important in governing train movements.

AMERICAN PRACTICE.—*Philadelphia and Reading Railroad.*—This is a double-track coal-bearing road, 100 miles long, over which 100 trains are passed daily—chiefly heavy coal and freight trains one-fourth of a mile in length, intermixed with fast passenger trains. It is not blocked, in the full sense of the term, except at tunnels and where single tracks are occasionally used, but there are frequent block stations at curves and at dangerous points, called "signal-towers," from 30 to 50 feet high.

On the tops of these towers are two vanes, each with three faces—red, white, and blue, signifying danger, safety, and caution—which are lighted at night by "Luberg lanterns," consisting of sheet-iron cylinders in the angles and centre of the vanes, into which the lamps are raised by pullies after they have been lighted in the room below. These vanes are separated by a black board, against which the lights and colours are clearly seen, and this division permits the two vanes to be used to direct the movement of trains in opposite directions at the same

* The Committee consisted of J. Dutton Steele, Octavo Chanute, and Charles Fisher.

time. They are turned by simple levers, working upon round tables in the watchman's room, upon which are painted colours corresponding with the colours of the vanes and lights, so that the lever being locked upon any given colour on the table, the same colour upon the vane is known to be facing the approaching train. At some dangerous points, these signal-towers are in sight of each other, and at the tunnels they are connected by telegraph wires, and no train is allowed to enter either end whilst another is in the tunnel moving in the same direction. The tunnels are, therefore, blocked in the full sense of that term. At the grade crossings the towers are set in the angle of intersection of the two roads, and have one vane with four faces and two colours, arranged thus—



so that with every turn of the vane, one road is blocked when the other is open, and neither road can be opened without at the same time the other being blocked. When the approaches are obscure, both at the tunnels and crossings, repeating stations are placed at suitable distances.

At the crossing of the Philadelphia and Trenton Railroad there is a modification of this appliance, which is thus described by Mr. Ashbel Welsh:—

"A hollow cylinder, so elevated as to be seen by all concerned, has four openings, one each way for each road. Through these a revolving cylinder is seen, with a light in it by night, in which two opposite spots are white, all the rest red. When white is seen through the openings toward one road, allowing the trains to proceed, red will be shown through the others, and while it is being shifted, or when no train is approaching, red will be seen through all. No train is to proceed until the white is shown."

Semaphores are used as station signals, but only in a very subordinate way, and the switches are without signals except of the most primitive character, which can only be accounted for by the extensive and constantly flowing business which enables an unusual amount of police attention with hand signals to be given to points where danger would arise from their misplacement.

Targets, with red and white discs, are used by the repairs-men; they are attached to pointed iron rods, which are fixed in the ground at stated distances from the obstructions, so that the red stops the movement of trains on one track whilst the white allows them to proceed on the other.

Audible signals by whistle are—one note, stop; two. start; three, go back; and the gong signals correspond. Torpedoes are used as fog and danger or obstruction signals.

Colour signals are—red, stop; white, proceed; blue, caution.

Hand signals are—horizontal motion, stop; vertical, proceed; circular, go back.

Philadelphia, Wilmington, and Baltimore Railroad.—There is an unusual variety of signals upon this road.

The audible signals are also variable; trains at rest being governed by one set of notes, when in motion by another, and the bell and whistle signals do not correspond; torpedoes, hand and standard fuses, are used as danger signals.

New York Central and Hudson River Railroad.—This line has not an elaborate system, being worked largely by hand-signals. Semaphores are used to direct the movement of trains over the several entrances into New York, and the same—at drawbridges. All signals are kept standing at danger, and are only changed to safety when the way is clear. Audible signals, by whistle and gong, are—one, stop; two, start; three, go back; but they do not correspond on the Hudson River and New York Central portions of the line. Colours generally have their usual significance, but in some cases red balls and lights give the road to trains passing west, and white to those passing east.

Boston and Providence Railroad.—This road is worked by ball signals, but they are not uniform in their significacation. Black balls and red lights, red balls and red lights, white balls and white lights, and black balls with white belts and red lights have the same meaning at different stations upon the road. The crossing of the Boston and Albany Railroad is worked by Mr. George F. Folsome's "Improved Signal Device," which consists of a box-shaped lantern provided with blinds that are opened to display the lights; an ingenious contrivance is added, by which the same lever motion which opens one set of blinds locks the other.

Eastern Railroad of Massachusetts and Maine Central Railroad.—This line is worked by the same ball system as the Boston and Providence, and has the same want of uniformity; the memory of the engineer is taxed with a separate set of rules for each tunnel, bridge, crossing, and station. The audible signals are—one, stop; two, start; three, go back; with torpedoes as danger signals. The electric system of Mr. Thomas S. Hall is being introduced upon those roads; we may add that, on the approaches to Boston, the full block system would seem to be desirable; and the same may be said as to the railway approaches to New York and other large cities.

On our Eastern roads generally the audible signals are —one, stop; two, start; three, go back; but the gong notes do not always correspond with the whistle. The motion signals are—horizontal, stop; vertical, start; circular, go back; and the colours—red, stop; blue, caution; and white, proceed; but there are frequent variations which do not seem to be predicated upon any sufficient cause.

Detroit and Milwaukee Railroad.—This road is worked by semaphores as block and station signals and at crossings and bridges. Targets are used at switches, and red and green flags. A special feature of the system is that the drawbridges are kept open except when the trains are passing, and of course the signals are at danger; this probably results from some requirement of the navigation; the system is simple and effective. The audible signals are—one, stop; two, start; three, go back; red, white and green being the colors, with the usual significance.

Lake Shore and Michigan Southern Railroad.—The movements of trains into the principal stations of this road are directed by semaphores; the horizontal, vertical, or oblique position of the arms indicate the direction in which the trains must move, and semaphores guard the crossings.

Roads worked by the *Pennsylvania Company* have the same general system which has been described on the Western roads; double semaphores are used at the crossings and drawbridges, the position of the arms indicating the state of the tracks, the audible and colour signals having the usual significance.

Hand and audible signals prevail upon our Western roads, the sparse settlement of the country making fixed signals less necessary, possibly less reliable, and more costly in proportion to the traffic than here in the East. It is, however, there that uniformity in the system is of the greatest importance, owing to the migratory character of the train-men and the close business connection of the roads, but such is not found to exist at present in practice. Mr. John M. Goodwin, in an article upon railway signals in the *Railroad Gazette*, thus describes this variation:—"On one road a lamp, moved up and down, is the signal to stop, on a connecting road the same signal means go back; on one a single note of the whistle means go ahead, on the other go back; on one road red is the standard signal for danger, and yet, at three several points on the same road, that colour means that the road is clear for trains from a certain division, clear for trains of a certain class, and clear for trains moving in a certain direction." This, however, is an extreme case, but there is an un-

necessary want of uniformity and although hand and audible signals are largely depended upon, semaphores (frequently called targets) are coming into extensive use.

Erie Railway.—The colour, hand, train and audible signals upon this road are substantially as usual on the Eastern roads. At the crossings, intersections, and bridges, ball signals are used, inside of which are lights at night. The general principle upon which they are worked is, that the exhibition of red balls stops all trains upon the main road, their absence, or the exhibition of white balls, permits the trains to proceed; but special directions are given for each point of danger. At Bergen tunnel there are targets at either end connected by a telegraph wire; but the tunnel is not *absolutely* blocked if we are to judge from the following clause in the "Instructions for Running Trains."—"In case the signal back to signify that the train has got through the tunnel is not received within fifteen minutes after the train has gone in, any following train may proceed, running with great care and looking out for signals; but a second train shall not be permitted to enter the tunnel until two signals are received to signify that both trains have gone through, and that the tunnel is clear." The great pressure of business through this tunnel is probably the reason for the latitude given, but the economy of time is doubtful whilst the risks are certain.

Pennsylvania Railroad.—The reports from this road are not full, but the good English switch signal, as well as the semaphores for block and crossing signals, with some improvements for repeating distant signals, are in use.

The notice of American railway signals would be incomplete without a reference to Hall's system of "Automatic Electric Railway Signals," which is now being introduced upon several Eastern roads and is claiming public attention. In principle it is the same as has been largely experimented upon in Europe. Vanes are moved and gongs are sounded by making or breaking the connections of an electric current. The practical objections made to the system by English writers are: first—the liability to derangement of the delicate mechanism employed, by the jar of passing trains; second—the changes in the strength of the electric current from continued use and from atmospheric influences; and third—that lightning will sometimes take possession of the wires and give wrong signals. It is not necessary to compare the mechanism of the English and American devices, further than to say that Mr. Hall claims to have overcome many of the objections by his mechanical arrangements which are now before the public and must establish their own reputation.

English Practice.—A paper of Mr. Rapier, read before the Institution of Civil Engineers, contains a detailed historical account of railway signalling in England from the time when a tallow candle in a cottage window indicated that the train must stop for passengers, through the periods when the roads were worked by hand and train signals, as is the practice in our sparsely settled districts, to the primitive block system as in use on the Philadelphia and Reading Railroad, and up to the full block system recommended in Mr. Welch's report. We, therefore, are passing over the same ways of experience as were travelled by our European neighbours, and as an increase of traffic presses its necessities upon us, we must reach the same general results. It may, therefore, be interesting to take a cursory view of this anterior practice, and of the discussions as to its merits among those who have had the advantage of personally observing its workings. We quote from Mr. Rapier's paper:—

"The demand for increased signalling facilities is not confined to this country, but has arisen in other European countries."

"Against errors on the part of those in charge of trains, the only safeguard is to be found in the complete block system, and of means to enable the drivers to observe signals well in advance."

"Under the absolute block system the signalman at station *A* is not permitted to send a second train to station *B* until he has received a signal from *B* that the first train has arrived there."

"Under the permissive block system it is simply permitted to signalman *B* to block signalman *A*, in the event of anything occurring which may render such a course desirable."

"The permissive block system has been well tried on the principal railways, and is preferred by some because it enables trains to be sent one after another with greater rapidity, but it affords very little protection, and it is now generally agreed that intermediate stations must be erected on the lines of constant traffic."

"When the distance is so great between any two stations as to cause the line to be blocked for too long a time, the best plan is to interpose one or more intermediate stations. The distance apart of signal stations seldom exceeds four miles, and it is often only a quarter of a mile, the average being one and a half miles."

"The Metropolitan Railway between King's Cross and Moorgate Street is laid with four lines of rails * * * and the number of trains passed over them is 768 daily, or one in every 1¾ minutes nearly."

"On the Great Eastern Railway 220 trains per day pass over the same metals."

"Mr. Finley, manager of the London and North Western Railway, stated that the block system had been adopted on about 800 miles of the 1630 miles of opened line belonging to that company, and that it was to be extended to the whole of the main line."

"Mr. Spagnoletti remarked that the marvellous increase of railway traffic in the past ten years was proof of how much had been gained by mechanical and electric assistance; had not these appliances been used, the only alternative would have been to double the railways."

The English practice is rapidly settling down to the abandonment of much of the variety which has heretofore existed in signals upon the several roads, and to the use of semaphores for block and station signals, and to targets (sometimes called discs) for switch signals. As points of detail, it is urged that there should be in that country—identity of type of signals for trains on their journey; for trains at stations, and of those meaning stop and go on, also identity in the relative position of signals for high and low speed lines.

(To be continued.)

NOTES.

The duties of telegraph clerks in Australia would seem to be as strictly apportioned as in England, and mistakes are as rigorously punished. From a printed copy of the "Rules and Regulations for the Guidance of Railway Clerks in South Australia," we find that a fine of £100 is inflicted for divulging a message, or, in default, imprisonment with hard labour for any period not exceeding six months. The rules apparently leave nothing unnoticed from the hours of attendance to the important duties of signalling trains. The clerk is provided with the calls of 101 stations, instructions for charging the main and local batteries, the future signals to be used in inter-office communications relating to the general business and working of the line, and he is also provided with all the abbreviations.

We have received the programme of the Royal Rhenish Westphalian Polytechnic School at Aachen for the course 1875-76. We are glad to find that the study of electri-

city, and of its application to telegraphy, are not overlooked. There is a course of experimental physics under the conduct of Prof. Wüllner, occupying four hours weekly. The whole territory of physics is demonstrated experimentally in as complete detail as time allows. Magnetism; terrestrial magnetism; frictional electricity; the behaviour of electricity in the state of insulation; induction; electrical machines; discharge, and its effects; origin and laws of formation of the galvanic current; determination of the resistance of conduction, and of the electro-motive force; thermo-electric currents; thermic and photogenic action of the current; electro-chemistry; magneto and electro-dynamic action; diamagnetism; electro and magneto induction, and the effects of induction currents; are all duly considered, Dr. Wüllner's admirable "System der Physik" being followed as a text-book. The same Professor conducts also a course—three hours weekly—on the mathematical bases of physics, including the mathematical theory of galvanic currents, of electro-dynamics, electro-magnetism, and of induction. As soon as the summer session begins Dr. Winkelmann gives a course of two hours weekly on the physical foundations of electro-telegraphy, going through in succession, Volta's fundamental experiments; measurements of contact electricity with the electrometer and condenser; the galvanic current, batteries old and recent; relations of the current determined by Ohm's law; measurement of the strength of the current by its chemical and galvanometric effects; relations and measurements of the conductive resistance measurements of electro-motive forces· polarisation; theories of electro-motive force and of conductive resistance; relations of the formation of currents; charges of the condensers; resistance of insulating layers; law of the amounts of charge in cables; duration of charge; general speed of the propagation of electric conditions; foundations of electro-magnetism; magnetising force; laws of free magnetism and attraction; saturation; foundations of induction; Voltaic induction; extra currents; magnetic induction; retardations of electro-magnetism; utilisation of induction in telegraphy; induction apparatus; electric behaviour of the earth; conduction by the earth; influence of atmospheric electricity upon telegraphy; aurora borealis, and its currents. Herr Wark, Inspector of Telegraphs, gives a weekly course of two hours during the winter session in practical telegraphy. Full instructions are given on every point connected with laying down telegraphic lines by land and sea; on the various instruments, their use and advantages; and the students are practically exercised by means of lines and apparatus established for the purpose. It is interesting to note that the highest possible charge for the whole course, Oct. 11 to July 31, in case of a student who attends the maximum of hours in the various class-rooms and laboratories, is 180 marks, or about £9. Cheapness is not attained here by inferior quality, since the professors are men of distinguished merit, and all the appliances for study, library, apparatus, museums, models, &c., are excellent. Has England nothing to learn from this?

A correspondent writes to the *Times* respecting the method of enabling ships to speak to each other in a og or at night by adapting either the Morse or Colomb combination to short and long sounds on the steam-whistle or fog-horn by which any of the numbers in the signal-book could be given. The combination alluded to consists of short and long flashes of electricity in the Morse and of light in the Colomb system, by which in the latter any numeral up to ten is given. The writer wisely directs attention to the fact that during the day all well-found ships are enabled to speak to each other, and constantly employ one or other of the flag codes for reporting their names, correcting each other's longitude, &c.; but when night or a fog falls on them the mercantile marine are little in advance of the days of Noah, while vessels of the Royal Navy, by using Captain Colomb's flashing lights, continue to speak to each other by night as easily as by day, and require only to adapt his numerals to their fog-whistles to make them independent, as to signalling, of all weathers.

It has been decided that the next International Telegraph Conference shall meet in London in 1878.

Although the actual laying of the cable of the Direct United States Cable Company was completed some time since, it has not yet been opened to the public for the transmission of messages. The delay is occasioned by a fault in the cable. The *Faraday* having gone out on a repairing mission, the difficulty will very speedily be remedied.

NOTICES OF BOOKS.

Machines Magnéto-Electriques Gramme. By ALFRED NIAUDET-BREGUET. With seven figures and two plates. Paris: Hippolyte Fontaine, 1875. Pp. 37.

THIS pamphlet explains in a very readable form the principle of Gramme's Magneto-Electric Machine. It also contains detailed information regarding its practical applications, and woodcuts are given showing the form of machine used for electrotyping, the production of the electric light, &c.

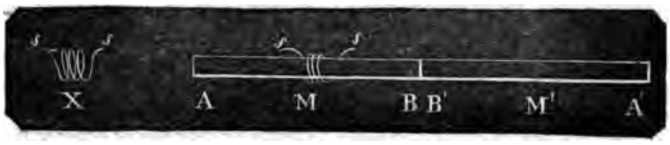
Previous to the great improvements effected by M. Gramme, magneto-electric machines furnished currents of rapid reversals, or were continuous only by means of complicated armatures and high speed. Hence until M. Gramme applied his system, whereby continuous currents were produced, magneto-electric machines were not used extensively for industrial purposes. Now, however, they are largely used for lighting and electroplating; and we believe that, as their splendid qualities become better known, they will be applied to other branches of the manufacturing arts.

The manner in which continuous currents are obtained by M. Gramme, and by which the principle of a magnet inducing a current is utilised, is well known to many of our readers; but there are others to whom M. Breguet's clear description will be instructive.

Take a magnetised bar, A B (Fig. 1), and an insulated copper spiral, S S. If the spiral from its position X approach the bar, A B, an induction current will be set up in it; and it will be found that the direction of the current for every series of movements from X past A on to M (the middle of the bar, or technically speaking, its neutral line) will be in the same direction. The direction, however, will immediately change if the spiral be passed further

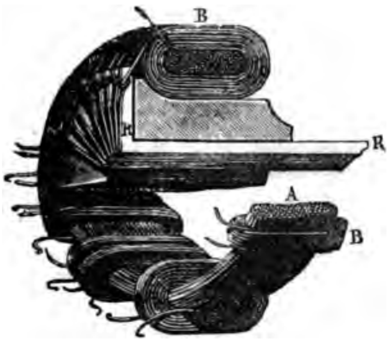
along the bar, from M to B. Thus during its entire passage along the magnet, two distinct periods are observable: in the one half of the bar the current is inverse in direction to that generated in the other half. Should the

Fig. 1.



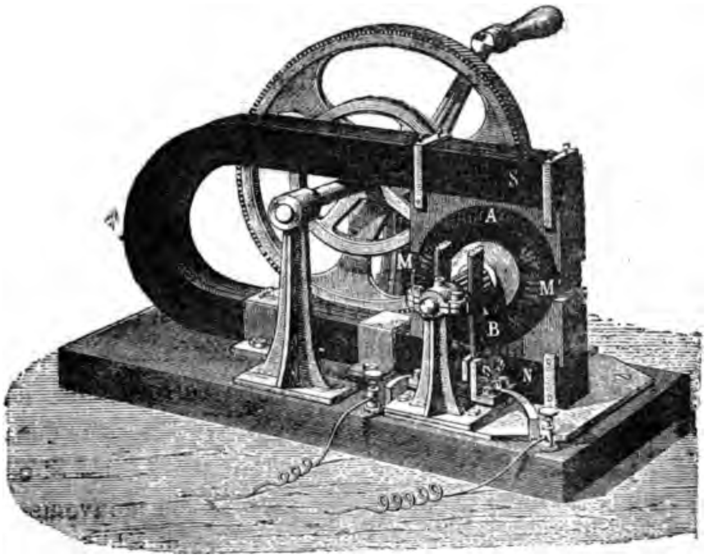
spiral be moved from B to A, the opposite effects are the result. Now add to the end of the first magnet, A B, another (precisely similar), which call B' A', as represented in the woodcut; and let the poles of the same name be conjoint. The consequence of now moving the

Fig. 2.



spiral along the complete double magnet will be a current, which call *positive*, from A to M; then a *negative* one from M to B; again a negative current from B' to M'; and, lastly, a *positive* current from M' to A'. Thus at the two

Fig. 3



neutra points M and M' the current changes its direction. Thus much for the principle; now for the application of it. The chief instrument by which this is effected is the "ring (Fig. 2 and it fulfils the office of the spiral and magnet just referred to. As shown in the engraving, a section of the ring is cut away, and the drawing otherwise arranged, to show its different parts.

In one small portion the ring is represented entire; in another the coils are depicted in couples; further on, singly; and lastly, the ring itself, composed of a bundle of soft iron rods is left bare. This soft iron ring turns around its centre between the poles of a permanent or an electro-magnet; and A and B, as in Fig. 3, are its north and south poles, whilst M and M' constitute the neutral points. During the motion of the ring in its revolution, this distribution does not change; that is, the poles are always at A and B, whatever portion of the ring arrives at those spots. In other words, during the entire revolution of the ring all its parts have in turn assumed north and south poles and their intermediate states, inducing in those several coils embracing the ring a series of instantaneous induced currents. These currents are all positive in one half of the ring, but negative in the other half; and if the discharges from the coils can be carried off as produced, the result is a continuous current.

The figure shows how these discharges are carried away. R, R, represent radiating metal stems insulated from one another, one between every two coils, and projecting beyond the ring in the form of an axle. The other end of these pieces are attached to the *ingress* end of one coil and the *egress* end of the next: all the coils are thus in electrical union with each other, and by a suitable arrrangement of friction collectors, at the neutral points, rubbing against two or three of the radiating metal pieces, the current as fast as generated in either half of the ring is carried away to line: the upper current by one rubber, the lower current by the other rubber.

At first it would seem that the resistance of such machine should be constant; but it is not so because th

strength of the current is not proportional to the speed of an invariable circuit. The difference, is, however, so trifling that for practical purposes it is accounted absolutely constant. Being practically constant, it thus possesses an enormous advantage over the ordinary voltaic battery so long as the velocity of rotation is uniform. The voltaic battery is complicated, since it is composed of at least six portions, viz.—porous cell, outer jar, two plates, and a compound liquid. The natural result is therefore that voltaic batteries often fail from internal derangements; whereas with the Gramme magneto-electric machine it is almost impossible for an interruption in the current to occur, the parts all being solid and simple in construction.

The machines made for lighthouse purposes, and requiring strong currents, are constructed with electromagnets, instead of permanent magnets, and they can work at a very high speed (935 turns a minute, according to M. Breguet), without getting heated or emitting sparks. From this we conclude that all the mechanical force transmitted to the machine is converted into electricity, since none is changed into heat. A remarkable property of this machine is that, if set in motion by a force just sufficient to turn it with a definite velocity when the exterior current is flowing, and if the outer circuit is suddenly broken, the machine is seen to acquire an increasing velocity, showing that the mechanical force applied to it, being no longer able to go off as electricity spends itself then in augmenting the velocity of this machine.

By means of the reciprocity which this has in common with other magneto-electric instruments, M. Gramme looks forward to its being adopted in places where the forces of nature are not utilised. He says: "Since a current is generated in the machine from mechanical force, a current will reproduce mechanical force; so two machines being at a distance, the turning of one will set in motion the other." Such being the case, what difficulty exists, M. Gramme asks, to make some of the powerful waterfalls turn his machines, and indirectly turn duplicates a mile or two away in the nearest town, in factories where expensive steam appliances are now required. Or what, he asks, is to prevent the establishment of factories in places where machinery is not used because of the expense attending steam power, but which could be profitably worked by his machines from spots where immense natural mechanical force is now wasted. Enterprising speculators will, perhaps, endeavour to carry out the suggestion when the great advantages of this class of machines are more widely understood and appreciated.

ELECTRICAL SCIENCE IN FOREIGN JOURNALS.

(This column is devoted to a list of Electrical Memoirs published in Foreign Journals. Those of importance will be either translated in full or given in abstract.)

Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences. Vol. lxxxi., No. 1, July 5, 1875.

The Distribution of Magnetism in Bundles of Infinite Length, composed of very Thin Plates.—By J. Jamin.—A continuation of the article which appears on pages 16 and 27.

Second Note on Tubular Electro-Magnets of Multiple Cores.—By the Count Th. du Moncel.—Included in the paper in our first number.

The Processes of Magnetisation. — By J. M. Gaugain.—On the 19th April, 1875, he indicated the distribution of the magnetism which is established in a bar of steel when its middle point is in contact with the pole of a magnet. This distribution depends on the angle which the magnet and bar make; and, when the curves of demagnetisation, which correspond to the various inclinations of the magnet are compared, we get a general conclusion that the angle being made to vary from 0 to 180°, the magnetisation increases with its magnitude. This fact may be directly verified by tracing the series of the demagnetisation curves corresponding to the different angles; it suffices to cause the magnet to revolve around the point of contact, and to ascertain the direction of the induction currents, developed during the movement, in a small helix placed successively on the different points of either of the halves of the bar. This law, however, is not true when the angle exceeds 90°: the magnetisation, instead of increasing, then decreases. It does not recommence to increase until a certain limit has been cleared—a limit which, under the conditions of M. Gaugain's experiments, is near upon 120°. This apparent anomaly is supposed to be simply due to the contact not being at all times the same; for a cylindric bar and a magnet of rectangular section are in contact only upon a single point until 90° is reached, when the contact extends to the whole thickness of the magnet. Another and more important irregularity is shown at the commencement of the rotation, when the magnet is removed from 0° to 30° or 40°: the magnetisation of the parts of the bar, bordering upon the point of contact, goes on augmenting conformably to the general rule; but that of the parts situated at a greater distance diminishes. This at first surprised the author, who supposed the magnetisation of the bar resulted exclusively from its contact with the magnet, and that it was transmitted to its successive sections by degrees. By that hypothesis, it could not be understood how the sections remote from the point of contact could acquire magnetism, whilst those more near this point lost it; but the observed fact explains itself very naturally on admitting that the magnet exercises at a distance a lateral action that diminishes in strength as the magnet leaves the bar. The magnetisation arising from the pole, and which transmits itself conductively, goes on increasing; whereas that which results from lateral action decreases. Hence the magnetisation situated near the point of contact grows, because it depends chiefly on the polar action; and the magnetisation of the remote portions decreases because it depends principally upon lateral action. When the point of contact is transferred to the extremity of the bar, the curve of demagnetisation is only of one single branch. The inclination of the magnet, nevertheless, acts the same as in the preceding case; but the first of the two anomalies is not met with. After exceeding the angle of 90°, the magnetisation continues to increase without retrogression. This is to be expected because the surface of contact is always limited to a single point (the plate being extremely thin); the second anomaly continues to exist, as it should. In a third case, let the point of contact M be between the middle of the bar and one of its extremities, which call B, the other extremity being called A, the curve of demagnetisation will, as a rule, be composed of two branches. From extensive analyses it appears that there is really an advantage in inclining the magnet, as it is customary to do in the method of magnetising a bar of iron by "single touch." Indeed, if the magnet is pushed from B towards A, and if it incline to the side A, the magnetisation developed behind it will be always greater than if it were perpendicular to the bar. If the magnet incline to the side B, and the movement continue to be from B to A, the magnetisation will, on the contrary, be weaker than if the bar were perpendicular. Treatises referring to the manufacture of magnets by "simple touch," give 25° to 30° as the most convenient angle to be given. The author thinks this angle is only given for convenience of working since, in his experiments, he inclined the magnet from 45° to 2° or 3°, and always found the result to be more powerful a the angle was smaller.

Les Mondes. Vol. xxxvii., No. 10. July 8th, 1875.

This number contains nothing suitable for our column

Annales Telegraphiques. Third series. March, April, 1875.

Review of Electrical Apparatus used in working French Railways. — M. Amiot, Inspector of Telegraphs.

The Destruction of Wooden Posts.—M. Bourseul, Sub-Inspector of Telegraphs.—Reserved for future translation.

Electric Standards and their Measurement in Absolute Units.—M. E. E. Blavier.

Automatic Control of the State of the Line.—M. Bernier, Controller of the Telegraph of the Orleans Railway.

Annales de Chimie et de Physique.
May, 1875.

Application of Electricity to Firing of Mine-Chambers, Torpedoes, &c., and to the Mining Industry.—MM. Champion, Pellet, and Grenier.—The authors describe recent improvements (through researches, partly their own) in the art of electric blasting. Among the topics successively dealt with are the induction apparatuses and batteries used; wires and fuses (the theory of the latter being fully discussed and varieties described); numerical examples and problems; such as, given a battery and the distance from the place of explosion, how many fuses may be fired? Cartridges for explosion of wet gun-cotton; simultaneous explosions, tension and induction fuses.

June, 1875.

Studies on the Transformation of Iron into Steel by Cementation.—M. Boussingault.

Relation between Nature of Steels and their Coercive Force.—MM. Trève and Durassier.—The authors had five steels prepared with different proportions of carbon; and they hardened each in three different ways (after heating to 767°—800°); viz., immersion in water at 10 degrees, in boiling water, and in oil at 10°. The bars were then magnetised and their magnetic force determined. With the highest proportion of carbon, the mode of hardening has not a very marked influence on the magnetic force; but as we come down the scale, the action is distinct. Hardening in cold water keeps the lead to the bottom of the scale (i.e., the bars thus treated and magnetised give the greatest deflection.) To the maximum of carbon (meaning thereby 1 to 1·150 per cent), corresponds the magnetic maximum. But the coercive force increases very little in steels raised above 0·500 or 0·550 of carbon; which proportion is sufficient for the magnets used in magneto-electric machines. For magnetic needles, the full proportion should be preferred. Carbon appears, lastly, to confer magnetic capacity on steels as well as elasticity.

Employment of the Tuning Fork in Electric Telegraphy.—M. La Cour.—In ordinary telegraphy only two simple signals are produced, either by opposite currents, or by prolonging, more or less, the duration of one current. M. La Cour produces a great number of simple signals with one wire. A tuning fork is caused to open and close an electric circuit at each vibration; and these pulsations of current act electro-magnetically on a second fork in unison with the first, putting it in vibration. In this receiving instrument, the branches of the fork are each enclosed (with freedom for oscillation) in a bobbin; the bobbins receive the intermittent current, which then passes to an electro-magnet so placed that its two poles are close to the two opposite poles produced in the branch-extremities of the fork. Thus the current produces an attraction (when it passes), which opens the branches of the fork; when it ceases, the branches approach each other, and so on repeatedly. The vibrations quickly reach such an amplitude that one branch touches a slip of metal, closing the circuit of a local battery and giving a signal. The intermittent current makes only that fork speak which is in unison with the sounding fork. Thus, with a number of different forks at one station, and an equal number of receivers corresponding, we may produce an equal number of simple signals, each requiring only a simple movement; and each signal corresponding to a letter, figure, &c., dispatches may be sent more quickly than by the ordinary method. A signal may be sent to one of several stations without the others perceiving it. Several signals can be produced simultaneously by the same wire. Other advantages may suggest themselves.

July, 1875.

On the Rôle in Electric Phenomena of Insulating Substances in contact with Conducting Bodies.—M. Neyreneuf.—In this paper the author first investigates the action of the insulating plate in ordinary phenomena of condensation, as in the discharge of a Leyden jar, and shows that the fluids do not abandon this plate, as is supposed, but that it acts, like the glass plate of the Ramsden machine, by influence on the conductors. He thus explains various experiments, (several of which are his own device), and he entirely assimilates the condenser to the electrophorus. The electromotive force of the insulating plate, in a condenser, is opposite to that of the statical source of the charge, just as the polarisation of the electrodes in dynamic electricity occasions the production of a secondary current opposite in direction to that of the principal. M. Neyreneuf studies the circumstances, conditions, and limits of the charge and phenomena of discharge. He further studies the influence of electricity on gases, and describes a number of experiments with the tourniquet and with flames.

Nachrichten von der Konigl., Gesellschaft der Wissenschaften zu Gottingen. Nos. 10 and 11, 1875.

Researches on Magnetism of Steel Bars.—M. Fromme.

Oscillations of a Magnet under the deadening influence of a Copper Ball.—M. Himstedt.

Berichte uber die Verhandl., der Naturforschen Gesellschaft zu Freiberg. Bd. vi., Heft 2.

Galvanic Glowing of Metallic Wires.—M. J. Müller.

Dingler's Polytechnisches Journal.
June 1.

Application of Electromagnetism in increasing the Pressure of Locomotive Wheels against the Rails.—M. Dreyfus.—The writer sketches the history of this subject and describes an arrangement recently devised by M. Bürgin. The entire axle, with its wheels, is made into one electromagnet. The wire is wound, with increasing thickness from the middle towards the wheels, in the case of external cranks; but uniformly, in the case of internal. With coupled wheels the wire is so arranged that there is an alternation of poles, the piece of rails between two poles forming the armature. A locomotive model (without engine or boiler), having three pairs of wheels, and internal cranks, was placed on a line with 30 per cent incline; the current for the wires was supplied from five Bunsen elements. The moving force was a weight of 12 k., with cord passing round the axles. The machine weighed 8·5 k., and with no current flowing, the wheels merely slid on the rails in position; but when the circuit was closed the model ran up the incline. When the brake was applied (and weight detached) the model could be held on the steep incline if the current was passing; but if not the wheels began to slide and the locomotive went downwards with increasing pace; but this descent was promptly stopped when the current was made to flow again.

Il Nuovo Cimento. Serie 2., Tomo xiii.

Experiments on Electricity furnished by the Friction of two Substances.—M. Pacinotti.

On Electrostatic Measurement of the Electromotive force of Induction.—M. Donati.

On the Temporary Magnetism of a Bar of Iron.—MM. Donati and Poloni.

Reale Istituto Lombardo di Scienze e Lettre.
Rendiconti vol. 8., Fasc. i and ii.

Results of Observation of the Diurnal Oscillations of the Declination Needle during the year 1874, at the Milan Observatory.—M. Schiaparelli.

Poggendorff's Annalen der Physik und Chimie.
No. 4, 1875.

On Unipolar Conduction of Electricity through Gas Layers of different Conductivity.—M. Braun.—Reserved for separate note.

Studies on the Currents of Electric Machines.—M. Rossetti.—See p. 26.

Electric Fall-Machines.—M. Waldner.—These are for demonstrating the laws of falling bodies. In one arrangement a brass ball is hung by a thread some height above the ground. Under it, at distance = 1, are two metallic balls connected with the poles of an electric machine; they are so far apart that a spark cannot pass between them, but if the suspended ball drop between them a spark will pass. Further down, at distance = 4, then = 9, &c., are similar pairs of balls. The thread of the suspended ball being burnt, the latter falls between the successive pairs, giving passage at each pair, to the current, and simultaneously, the spark in another part of the circuit strikes a revolving soot-blackened drum, making a mark. The distances between successive marks are found to be equal. In a second arrangement, there are two cylindrical conductors, insulated and vertical, with a metallic ball suspended between them at the top, hardly filling the interval, and sufficient to enable a spark to pass between the cylinders, which are connected with the poles of an induction (secondary) coil. One of the cylinders has a coating of soot-blackened paper. The thread is burnt, and the ball falls; sparks are made to pass at regular intervals of time, by means of clockwork, interrupting the battery current. Each spark leaves its mark on the blackened surface; and thus are shown the spaces passed over in equal times.

Experimental Determination of Diamagnetism through its Electric Inductive Action.—M. Töpler.—In the improved methods here described the case is simplified by no movement of the diamagnetic body being involved. For example; two spirals are inserted one behind the other in a battery circuit; and within these, two induction spirals (*a* and *b*), which are opposite and connected through a galvanometer. Thus, on opening and closing the primary circuit, the difference of the inductions is indicated. But this difference is eliminated by means of an auxiliary spiral to the weaker spiral (say *b*); which is inserted in the galvanometer circuit and moved towards the primary spiral till the galvanometer action on opening and closing disappears. A diamagnetic body is now put in the middle of the spiral *a*; and on opening and closing the primary circuit the inductive action is shown by the galvanometer.

Some Researches on Thomson's Electrometer.—M. Holmgren.—The author notices some sources of error in use of the instrument.

Electroscopic Notice.—The editor showed some time ago that the amalgam used in electric machines makes all bodies rubbed with it positive, even those held to be the most negative. He now recommends, that instead of rubbing the ebonite, used for charging electric machines, with cat's fur, woollen cloth, or the hand (making it negative), it be rubbed with amalgam (making it positive). The process is thus facilitated and succeeds though the atmospheric conditions be unfavourable.

PATENTS.

APPLICATIONS FOR LETTERS PATENT.

2434. William Stroudley, engineer, and Stephen Rusbridge, inspector, both of Brighton, for an invention of "Improvements in apparatus for and in the method of signalling between parts of a railway train, parts of which apparatus are applicable to or for other purposes."—Dated July 6, 1875.

2440. William Hinds, engineer, of Ironmonger Row, Old Street Road, London, and Donald Nicoll, Esq., justice of the peace, of 15, Clements Inn, Strand, London, for an invention of "Improvements in machinery for laying down and taking up detonators or fog signals on railways, and in signalling thereby.—Dated July 6, 1875.

2472. William Edward Gedge, patent agent, of 11, Wellington Street, Strand, Middlesex, for an invention of "Improvements in apparatus for signalling on railway trains."—A communication to him from abroad by Baptiste Le Bret, of 2, Rue Lécluse, Paris, France.—Dated July 9, 1875.

2495. Christian Heinzerling and Henry Liepmann, both of Glasgow, Lanark, North Britain, for an invention of "Improvements in the recovery and utilisation of refuse caoutchouc and gutta-percha."—Dated July 12, 1875,

2509. William Robert Lake, of the firm of Haseltine, Lake, and Co., patent agents, Southampton Buildings, London, for an invention of "Improvements in galvanic apparatus and in contrivances connected therewith applicable to telegraphic and lighting purposes."—A communication to him from abroad by F. W. Wippern, of Meidling, near Vienna, Austria.—Dated July 12, 1875.

NOTICES TO PROCEED.

819. Walter Parker Smith, engineer, of Lostwithie Cornwall, has given notice in respect of the invention of "Improved apparatus or mechanism for interlocking railway signals, switch and facing point apparatus.

GRANTS OF PROVISIONAL PROTECTION FOR SIX MONTHS.

2309. George Tomlinson Bousfield, of Sutton, Surrey, for the invention of "Improvements in apparatus for the adjustment of magnetic needles."—A communication to him from abroad by George Iles, of the city of Montreal, in the province of Quebec, Canada.

2351. Alexander Melville Clark, patent agent, of 53, Chancery Lane, Middlesex, for the invention of "Improvements in telegraphic circuits."—A communication to him from abroad by William Edward Sawyer, of Washington, in the district of Columbia, United States of America.

2385. Austin Chambers, signal engineer, of 258, Marylebone Road, Middlesex, for the invention of "Improvements in pneumatic signals for railways."

PATENTS WHICH HAVE BECOME VOID.

1961. Lillias Jobson, widow and executrix of Robert Jobson, of Dudley, Worcester, for an invention of "Improvements in the manufacture of supports for telegraph insulators."—Dated June 29, 1872.

1987. James Fielding, of Manchester, Lancaster, for an invention of "Improvements in apparatus for conveying signals from one person to another in railway trains."—Dated July 1, 1872.

PATENTS GRANTED IN FOREIGN STATES.

AUSTRIA.

C. Clamond, of Paris for "An improved thermo-electric apparatus."—1 year. (Secret.)—Dated March 24, 1875.

A. Crespin, of Paris, for "Automatic relays for pneumatic conveyance of dispatches at a steady speed."—2 years. (Public.)—Dated March 29, 1875.

B. Egger, of Vienna, for "Improvements in copper-zinc batteries."—1 year. (Secret.)—Dated March 24, 1875.

Belgium.

37,244. E. Rolland and J. Delbrouck, of Ciply-Mons, for "An electric safety apparatus for railways."—Dated June 12, 1875.

37,246. C. Gay, for an imported invention of "An insulating coating."—Dated June 12, 1875.—(French Patent, June 9, 1875.)

37,270. A. Chambers, a Patent of Improvement for "Improvements in railway signals and in apparatus employed therefor."—Dated June 15th, 1875.—(Original Patent, December 14th, 1874.)

ABSTRACTS OF SPECIFICATIONS.

United States.

Stations for Submarine Telegraphs.—Robert F. Bradley, Moffetsville, S. C., March 29, 1875.—In ocean telegraphy, a station for placing intermediate points in communication with the land termini, constructed of a hollow sectional column which is supported on a universally jointed base-plate, and anchored, by stay-chains or cables, to bottom stay-plates secured by stakes, for carrying the branch cable from the main cable to the surface, substantially as and for the purpose set forth.

Electric Signalling and Recording Apparatus.—William J. Philips, Philadelphia, Pa., April 28, 1875.—Arranged so that a watchman may send in a signal to central office, announcing his visit to any post, and at the same time register by suitable devices the time of the visit upon a dial in the box, all in an ordinary district alarm system. 1. The combination, with an electric signalling or alarm mechanism, of a recording mechanism, for registering at the transmitting station the time of transmittal of a signal therefrom, substantially as set forth.—2. The double-faced signal-box, provided with the signalling mechanism and the clockwork register, substantially as set forth.—3. The combination, with the circuit-breaking wheel and motor train thereof, of a pencil or other marking point of a registering mechanism and suitable connecting devices, substantially as set forth.—4. A double-faced signal-box, provided with the flanges R S and bolts U, substantially as and for the purposes set forth.—5. In the registering mechanism, the pencil-arm M, composed of the rigid parts *m m'*, united by a spring slip or piece, *n*, substantially as and for the purposes set forth.—6. The combination with the arm M, provided with projection *e*, of the standard Q, provided with bevelled upper edge or end, substantially as and for the purposes set forth.

COMMERCIAL NOTES.

A telegram from Monte Video announces the completion of the last section of cable between that city and Chuy, close to the Brazilian frontier, where the Western and Brazilian Telegraph Company's system begins. The portion just finished belonged to the Montevidean and Brazilian Telegraph Company, which was taken over by the Platino-Brazileira and Western and Brazilian Companies. Direct communication from England is now opened, not only with the River Plate region by way of Brazil, but also by the overland wire with Chili, which is traversed by telegraphic lines from Valparaiso southwards to Talcatruano, and north to Caldera.

The Globe Telegraph Company recommends a final dividend of 3s. per share on the preference shares, making 6 per cent for the year, and 2s. 6d. per share on the ordinary shares, making 5 per cent for the year.

The West India and Panama Telegraph Company (Limited) have received intelligence that their s.s. *Investigator* has repaired the cable between St. Vincent and Barbadoes, and that all stations on their system are now in telegraphic communication with England.

The Eastern Telegraph Company's traffic receipts for the month of June, 1875, amounted to £30,211 against £29,819 in the corresponding period of 1874.

TELEGRAPH SHARE LIST.

Amount per Share.	Name of Company.	Amount paid up.	Closing Quotations.
£		£	July 14.
Stock	Anglo-American	100	59½—60
10	Black Sea	All	2—4
10	Brazilian Submarine	All	6¾—7¼
10	Cuba	All	7¼—8¼
10	Ditto, 10 per cent Preference	All	13—13½
10	Direct Spanish	9	4¾—5¼
10	Ditto, 10 per cent Preference	All	10½—11
20	Direct United States Cable	All	8½—9
10	Eastern	All	6⅞—7⅛
..	Ditto, 6 per cent Debenture	..	102—104
10	Ditto, Exten. Australia and China	All	7⅛—7⅜
10	German Union Telegraph and Trust	All	8—8½
10	Globe Telegraph and Trust	All	5¾—6¼
10	Ditto, 6 per cent Preference	All	9½—10½
10	Great Northern	All	9½—10
25	Indo-European	All	19—21
10	Mediterranean Extension	All	2¾—3¼
10	Ditto, 8 per cent Preference	All	10—10½
10	Panama and South Pacific	2½	..—..
8	Reuter's	All	9½—10½
Stock	Submarine	100	195—205
1	Ditto, Scrip	All	1¼—2
10	West India and Panama	All	2¾—3¼
10	Ditto, 10 per cent Preference	All	9½—10½
20	Western and Brazilian	All	13¾—14¼
1000 dls.	Western Un. U.S. 7 per cent 1st M.B.	All	105—107
100	Ditto, 6 per cent	All	88½—89½
10	Hooper's Telegraph Works	All	9½—10½
50	India-Rubber and Gutta-Percha	All	18—20
Cert.	Submarine Cables Trust	100	93—98
12	Telegraph Construction	All	24—25
100	Ditto, 7 per cent Bonds	All	100—103

At the meeting of the Eastern Telegraph Company held on Tuesday, the director's report was adopted. The dividend of 3s. 6d. per share, making 5 per cent for the year, is 1 per cent less than in the previous year.

The traffic receipts of the Western and Brazilian Telegraph Company (Limited) were £10,829 for the five weeks ending July 2.

The traffic receipts of the Eastern Extension, &c., Telegraph Company (Limited) for June amounted to £20,183 against £19,026 for the corresponding period of 1874.

The traffic receipts of the Brazilian Submarine Telegraph Company for the month of June amounted to £9478.

The traffic receipts of the Great Northern Telegraph Company for June were 393,080 frs.; last year, 386,374 frs. Total traffic receipts 1st Jan. to 30th June this year, 1,995,477 frs.; last year, 2,076,371 frs.

The receipts of the Submarine Telegraph Company for June were £9376 18s. 4d. Those for corresponding period of 1874, £9188 19s.

The traffic receipts of the Anglo-American Telegraph Company for the 2nd inst. amounted to £1340; on the 3rd, to £1150; on the 4th, to £310; on the 5th, to £720; on the 6th, to £1160; on the 7th, to £1290; on the 8th, to £1460; on the 9th, to £1350; on the 10th, to £1300; on the 11th, to £280; on the 12th, to £1110.

The Indo-European Telegraph Company (Limited) announces that the average time in transit between London and India of all outward messages to India and beyond, during the week ending the 9th inst., *via* Teheran, was 1 hour 31 minutes.

The directors of Hooper's Telegraph Works (Limited) announce that, owing to the absence of new contracts since the 1st of January, they have decided not to pay an *ad interim* dividend for the half-year ending the 30th June last. It is added, however, that negotiations are pending for several important contracts, and that one of considerable magnitude has been provisionally arranged.

*** Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which "The Electrical News and Telegraphic Reporter" is the organ, will always command attention. Literary communications and books for review should be addressed to the Editor; business communications to the Publishers, Boy Court, Ludgate Hill, London, E.C.

THE ELECTRICAL NEWS

AND

TELEGRAPHIC REPORTER.

EDITED BY WILLIAM CROOKES, F.R.S., &c.

TO ELECTRICIANS EVERYWHERE.

Since the day when Electricity was first discovered, until now, its vast importance and its high destinies have grown upon the human mind. Fresh phases of its power, fresh results, new means of obtaining and governing its action, and multiplied ends to which it may be turned, have constantly discovered themselves; till to-day it stands out as one of the grandest subjects presented to the scientific and practical world for investigation and research. Perhaps, however, no other Science or Art has exhibited so extraordinary a concurrence of anomalies. It is at once the most terrible monster and the most humble and obedient servant, its action is at one moment beneficial, at the next destructive; its range is boundless, yet it may be "cabined, cribbed, confined" at ease; it is everywhere present, while its nature is only imperfectly understood; and, to crown all, although it is one of the most important agents in the action and the phenomena of the universe, and increasing knowledge of its applicability to the needs of our race is of the utmost importance, no direct means of ascertaining the thoughts and discoveries of its students, or of bringing them before the scientific and mechanical community, at present exist. Attempts have been made to supply this want, and journals have been started with the professed object in view of making public all that is known or can be learnt of Electricity in all its branches. But they have degenerated into unscientific records of unimportant events, and the purpose for which they were established has been lost sight of. Thus it comes that—while Engineering, Chemistry, and other Applied Sciences have all their representative recognised organs—the Electrician finds himself without any current journal from which he can learn the events which are daily occurring of peculiar interest to himself.

Such a want has now been supplied by the establishment of the Electrical News and Telegraphic Reporter. In its columns will be found the most valuable opinions of eminent Electricians and scientific men all over the world. Articles will be contributed which will be of value not only to those who study Electricity as amateur experimentalists or scientific inquirers, but also to those whose daily life is bound up with the advancement of practical knowledge in all departments of the science, and who as electricians, telegraphists, electrotypers, electroplaters, and chemists have continually to deal with the same marvellous agent of force in different ways. Nor will the doings of foreign societies be ignored as in times gone by, but, in the shape of carefully prepared abstracts, their proceedings will be presented to our readers. Every opportunity will be given for the healthful discussion of the science in all its branches, and a fair unbiassed course will be steered in all questions of dispute.

This, then, is our Programme in brief. More we could promise, but prefer to let the new periodical speak for itself. The subject with which it will deal is of too great importance to need one word of recommendation. Daily experience teaches us that we are as yet on the threshold only of a vast expanse of electrical knowledge. This has to be explored, and as the research gains in strength and intelligence the results will be far beyond all present conception. The feat of girdling the earth in forty minutes will be eclipsed by great deeds yet to be done, and if the establishment of the Electrical News and Telegraphic Reporter conduces to the hastening of this desirable end our object will have been gained, and we shall be fully rewarded.

Boy Court, Ludgate Hill, London, E.C.
July 1st, 1875.

London: Printed and Published by the Proprietor, William Crookes, at the Office, Boy Court, Ludgate Hill, E.C. July 15, 1875.

THE

ELECTRICAL NEWS

AND

Edited by Wm. Crookes, F.R.S., &c.] **TELEGRAPHIC REPORTER.** [Registered for Transmission Abroad.

Vol. 1.—No. 4.] Thursday, July 22, 1875. [PRICE, 4d. POST FREE, 4½d.

CONTENTS.

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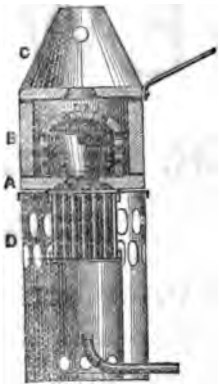

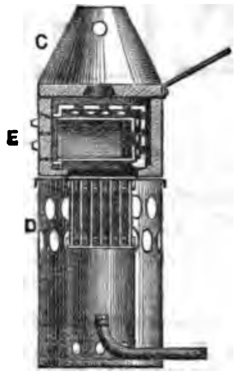

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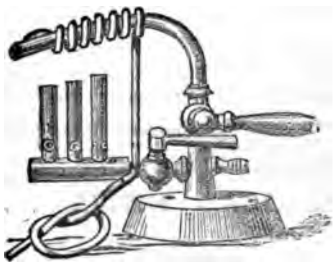

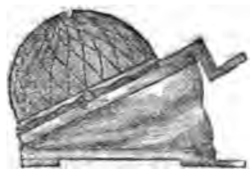

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THE ELECTRICAL NEWS.

VOL. I. No. 4.

THE COPPER-ZINC COUPLE AND ITS EFFECTS.*

By J. H. GLADSTONE, Ph.D., F.R.S.,
Fullerian Professor of Chemistry in the Royal Institution.

(Concluded from page 4.)

I WILL occupy the remaining half hour in bringing before you some of the work that has been done by means of the copper-zinc couple. On one of the papers handed to you at the door, I have given what has been done at different dates—the chief results and the chemistry of the operation, which will be perfectly intelligible to the chemists who are present. You will perceive a note explaining that the copper and zinc are not in any definite chemical relationship or quantity, in the formulæ given.

Let me first take the substance which I have spoken of most fully, that is to say, water. There is one experiment that I should like to show you, because it is so illustrative. Zinc alone put into water does not decompose it. Zinc and copper, as I hope to show you, do decompose the water. We can, however, take a metal which does decompose water even at the ordinary temperature. It is very much like zinc, but more power-

WORK DONE BY MEANS OF GLADSTONE AND TRIBE'S COPPER-ZINC COUPLE.

Date.	Chief Results.	Chemistry of Operation.
1872.	Decomposition of water, and preparation of pure hydrogen	$ZnCu+2H_2O=Cu+Zn2HO+H_2$
1873.	Direct formation of zinc ethiodide, and ..	$ZnCu+C_2H_5I=Cu+Zn\begin{cases}C_2H_5\\I\end{cases}$
	Preparation of zinc ethyl, ...	$2Zn\begin{cases}C_2H_5\\I\end{cases}=Zn\begin{cases}C_2H_5\\C_2H_5\end{cases}+ZnI_2$
	Ethyl hydride, and zinc *iodo-ethylate*	$ZnCu+\begin{cases}C_2H_5O\\H\end{cases}+\begin{cases}C_2H_5\\I\end{cases}=Cu+Zn\begin{cases}C_2H_5O\\I\end{cases}+\begin{cases}C_2H_5\\H\end{cases}$
1873.	Preparation of di-amyl, ...	$ZnCu+2\begin{cases}C_5H_{11}\\I\end{cases}=Cu+\begin{cases}C_5H_{11}\\C_5H_{11}\end{cases}+ZnI_2$
	Zinc-amyl, and	$2ZnCu+2\begin{cases}C_5H_{11}\\I\end{cases}=Cu+Zn\begin{cases}C_5H_{11}\\C_5H_{11}\end{cases}+ZnI_2$
	Amyl hydride	$ZnCu+\begin{cases}C_2H_5O\\H\end{cases}+\begin{cases}C_5H_{11}\\I\end{cases}=Cu+Zn\begin{cases}C_2H_5O\\I\end{cases}+\begin{cases}C_5H_{11}\\H\end{cases}$
	Preparation of methyl hydride	$ZnCu+C_2H_6O+CH_3I=Cu+Zn\begin{cases}C_2H_5O\\I\end{cases}+CH_4$
1873.	Preparation of *zinc isopropyl,*	$2ZnCu+2\begin{cases}C_3H_7\\I\end{cases}=Cu+Zn\begin{cases}C_3H_7\\C_3H_7\end{cases}+ZnI_2$
	Zinc prop-iodide, zinc propyl, and propyl hydride	$ZnCu+\begin{cases}C_3H_7\\I\end{cases}=Cu+Zn\begin{cases}C_3H_7\\I\end{cases}$
		$2Zn\begin{cases}C_3H_7\\I\end{cases}=ZnI_2+Zn\begin{cases}C_3H_7\\C_3H_7\end{cases}$
		$ZnCu+\begin{cases}C_3H_7\\I\end{cases}+\begin{cases}C_2H_5O\\H\end{cases}=Cu+Zn\begin{cases}C_2H_5O\\I\end{cases}+\begin{cases}C_3H_7\\H\end{cases}$
1874.	Isolation of di-allyl, and	$ZnCu+2\begin{cases}C_3H_5\\I\end{cases}=Cu+\begin{cases}C_3H_5\\C_3H_5\end{cases}+ZnI_2$
	Preparation of pure propylene	$ZnCu+\begin{cases}C_3H_5\\I\end{cases}+\begin{cases}C_2H_5O\\H\end{cases}=Cu+Zn\begin{cases}C_2H_5O\\I\end{cases}+C_3H_6$
1874.	Preparation of pure olefiant gas and its homologues	$ZnCu+\begin{cases}C_nH_{2n}\\Br_2\end{cases}=Cu+ZnBr_2+C_nH_{2n}$
1874.	Preparation of *zinc ethylobromide,* and ..	$ZnCu+\begin{cases}C_2H_5\\Br\end{cases}=Cu+Zn\begin{cases}C_2H_5\\Br\end{cases}$
	Zinc brom-ethylate	$ZnCu+\begin{cases}C_2H_5\\Br\end{cases}+\begin{cases}C_2H_5O\\H\end{cases}=Cu+Zn\begin{cases}C_2H_5O\\Br\end{cases}+\begin{cases}C_2H_5\\H\end{cases}$
1874.	Preparation of *zinc chlorethylate,* and direct hydrogenisation of ethylidene	$2ZnCu+\begin{cases}C_2H_4Cl\\Cl\end{cases}+2\begin{cases}C_2H_5O\\H\end{cases}=Cu+2Zn\begin{cases}C_2H_5O\\Cl\end{cases}+\begin{cases}C_2H_5\\H\end{cases}$
1875.	Complete hydrogenisation of chloroform, and	$3ZnCu+CHCl_3+3\begin{cases}C_2H_5O\\H\end{cases}=Cu+3Zn\begin{cases}C_2H_5O\\Cl\end{cases}+CH_4$
	Its homologues, and preparation of Acetylene	$3ZnCu+2CHI_3=Cu+3ZnI_2+C_2H_2$
	(Investigated by Prof. Thorpe.)	
1873.	Conversion of nitrates into ammonia	$4ZnCu+6H_2O+KNO_3=Cu+4ZnH_2O_2+KHO+NH_3$

The new substances discovered during these investigations are in italics.
Cu signifies simply the metal copper, and not an atomic proportion.

* Verbatim report of a Lecture delivered at the Royal Institution.

ful in most of its chemical characters, and it has the power of taking the oxygen away from the hydrogen even under ordinary conditions. We will endeavour to show that by throwing the image on the screen. Here is a vessel of water, and here is a little twisted coil of wire made of the metal magnesium. You will perceive that there are bubbles forming upon the metal. Now the water has got warmer, I dare say, by means of that powerful light behind it; still though certain bubbles are formed, you will perceive that the decomposition of water is going on but slowly. I will ask Mr. Williams just to put in a little of the blue solution of sulphate of copper which I have here; then you will perceive at once that copper is being deposited upon the magnesium, for the magnesium is growing thicker, and becoming rough with the deposition of metal upon it. Now the bubbles are forming in large quantity. You perceive that the copper and magnesium together are acting energetically upon the water, and the bubbles are forming very rapidly and rising to the surface of the liquid. This little experiment then, I think, will illustrate to you very clearly that the two metals in junction are more powerful than one alone, in decomposing water.

Now we will try this by means of zinc. Here is a good large copper-zinc couple which has been acting for some time, and here is some of the hydrogen gas which has been collected. You see it is working away slowly at the ordinary temperature. I will ask Mr. Williams to change the water—to pour away this water and take some warm water instead. I have put upon the board the amounts produced at different temperatures, in experiments which were performed carefully. At a temperature of 2° C., that is to say, only just above the temperature of ice, we got during twenty-four hours 1·1 c.c. of hydrogen gas. But when we operated at 22° C., that is to say, a little above the temperature of this room, we got 5·5, five times as much. When it was made warmer (34° C.) then we had 13·9, and so on. You may see how very rapidly these numbers increase with the temperature. The quantity of gas increased at a very much more rapid ratio than the increase of temperature; so that when we get to pretty nearly the temperature of boiling water, 93° C., we get about 500 times as much gas produced as we have when the water was nearly frozen.

This just illustrates the effect of temperature. Well, here the action is going on with the warm water. I dare say we shall see that the hydrogen gas is coming off more freely.

I will draw your attention to this piece of apparatus. It is one which was set up during the Christmas lectures. It was put aside in the laboratory, and I believe has not been touched since. It has been working on during all the time in the cold, and it has been doing its business quietly without stopping. It is still working. Here, in this tube, is an amount of gas which has been collected since yesterday. We have collected these 25 centimetres since about this time yesterday, when the apparatus was placed on the table, and we shall, no doubt, find that this is hydrogen gas. You will observe another result. We have a quantity of white oxide of zinc formed. The zinc has, in fact, turned almost entirely into oxide. We were reckoning just now that it must have given off 4000 c.c. of hydrogen if it went on at the rate that it is going on now; but certainly it has been acting more energetically during the earlier part of these four or five months.

One of Dr. Frankland's greatest discoveries was the discovery of ethyl and of a number of other substances, by acting upon iodide of ethyl by means of zinc at a very high temperature, and at high pressure. In this way he obtained the spontaneously inflammable zinc-ethyl and other bodies. Now we thought that the action which he obtained with difficulty, our zinc-couple would, perhaps, bring about much more readily, and we tried it, and found that such was the case. We have merely to take some of this couple and pour upon it the iodide of zinc, and we find that the iodide of zinc is gradually decomposed—that a solid substance first is formed in the reaction, and that this zinc ethiodide, as it is called, and a gas, are produced as Frankland found. If this zinc ethiodide be heated, it is resolved into iodide of zinc and the spontaneously inflammable liquid, zinc-ethyl. We can produce this in larger quantity, and very quickly indeed, by the use of the new copper-zinc couple. However, it is too slow a process for me to show you just now. I will show you simply some ethiodide of zinc which has been produced, and some of the zinc-ethyl which has been prepared in this way. I will take a little up in this tube, and you see as I allow it to pour down from the end of the tube it catches fire the moment it is brought into contact with the atmosphere.

But this couple will decompose a number of other substances of a similar character—iodides and bromides. It will decompose them much more easily than the zinc itself will, and much more quietly, and we can produce substances which we cannot produce without the couple.

I will next show you zinc-propyl—an analogous body which has never been prepared before; but it has been prepared by this means. It is like the zinc-ethyl in some of its properties, and I will repeat the same experiment to you, and show you that it also is spontaneously combustible. Here we have this liquid. As I allow it to run out it catches fire in the air at once, and from the blazing stream rises oxide of zinc, which floats away in the atmosphere. This, then, is one of the children of the copper-zinc couple, and a fiery child it is, as you see.

But we have some more fiery children. The zinc-isopropyl is still more active than that. I must not dwell too long upon these things. We can produce the ethylo-haloid compounds themselves by bringing their constituents together. We can take this zinc-ethyl, for instance, and warm it with iodide of zinc, when it forms Frankland's ethiodide. By using bromide of ethyl instead of iodide, I can produce a perfectly analogous substance. This ethylobromide of zinc we prepared some time ago. This is a substance which was never prepared before, but which was first obtained by means of the copper-zinc couple, and by heating it we can produce our inflammable zinc-ethyl just as from the iodide.

There is no reason why we should not have a chlorine compound like the iodine and the bromine compounds. This has been prepared by means of the copper-zinc couple. My first idea was to prepare it before you in my lecture to-day; but one does not like to make an experiment for the first time in a lecture-room, especially when dealing with such an inflammable substance as zinc-ethyl. One does not know what its habits may be when brought into contact with what it has never been in contact with before. This, therefore, was prepared on Saturday, and this is the first and the only specimen of the substance which has ever been prepared in the world. Here, then, is a new body which has never been seen before except by ourselves. Well, we must give it a name, of course, and what name shall we give it? We can only name it according to the family to which it belongs, and you perceive its brothers upon the printed table. Against the date "1873" we have the direct formation of zinc ethiodide. That was Dr. Frankland's substance. We produced afterwards the zinc ethylo-bromide, and you will perceive that it is put in italics in the table because it is a new substance. It is this pearly, crystalline body. This last we must call by the same name, putting "chloride" in the place of "bromide." So it stands as the "zinc ethylo-chloride." That must be the name of this new crystalline substance which we have just produced.

It must be remembered that we are only just launching upon this investigation. If, instead of taking the iodide of ethyl and acting upon it by means of the copper-zinc couple, we mix it with some alcohol, or water, beforehand, we get a different kind of reaction. We get the hydrogen of the water, or the hydrogen of the alcohol,

entering into the matter. That has been going on in this experiment which was started this morning, and I believe that the action has filled this vessel with gas two or three times. In this case the gas is what is called hydride of ethyl. In this other vessel we have a similar substance—hydride of methyl, or marsh gas—the inflammable gas of coal mines, or the inflammable gas which comes off from marshes. It will burn. [The marsh gas was caused to issue from the jar in which it had been collected, and was ignited].

This is the easiest way, by far, of producing these hydrides; but, at the same time, we are producing something else in the liquid. You who are well acquainted with chemical symbols will observe the chemical equation, and see that it involves the formation of some other body. There is a combination of the zinc and iodine and C_2H_5O. This is a new substance, which we have termed zinc iodoethylate. It dissolves in alcohol very freely, but not in water. Here it is. I will show you that it is decomposed by water by pouring a little into the water in this vessel. What we get is a thick precipitate of oxide of zinc and an alcoholic residuum. By similarly treating a bromide, we may get a similar bromine compound, and by similarly treating a chloride, we may get a corresponding chlorine compound. In fact, there are various ways in which these may be produced. I will ask you to look, after the lecture, at this beautiful gelatinous oxide of zinc which is floating about in the liquid.

One hardly knows how to refer to all the various substances that are here. We will take substances which are perfectly analogous one to the other, as far as composition is concerned. This copper-zinc couple is a quiet means by which we can split them asunder, or, rather, gradually take one element away from the other element; and in this way we can see how they are built up—what we may call their structure. In chloride of ethylene and chloride of ethylidene we have two such bodies, and they are acted upon differently by the couple.

We can produce other bodies by this agency. For instance, here is a specimen of di-allyl. Suppose we take chloroform, or bromoform, or iodoform; we find it easily acted upon. If I were to take iodoform dissolved in alcohol, and put some copper-zinc couple into the vessel, we should see an action taking place, with the production of mixed hydride of methyl and acetylen. This takes a few moments to commence, and then it becomes very energetic in its action. These reactions give about the best illustration that I know of the influence of time. It is very singular that many of them will remain quiescent for a quarter of an hour, or perhaps an hour, without any change being apparent, and then they begin to act, and the action becomes rapid and soon ceases. It is important to be very careful in bringing these substances together in the first instance, because we do not know whether a long time will elapse before the action commences, or whether, as in the case of bromoform, the whole contents of the vessel may be violently thrown out upon the substances being brought together.

Sometimes we are asked the question, "What is the good of these enquiries?" Well, the good is very various. That is generally the last question that we ask in experimenting. It ought to be the last question; but still it is interesting, at least to the public generally, to find that there are some practical results flowing from such investigations. The main results may be of a theoretical order. Our theories, views, or hypotheses, diagrams or illustrations, are all very imperfect. They represent but poorly what takes place in nature. But, by increasing our experiments, and getting more and more to the truth of nature, we advance our theories and improve our knowledge of natural things. It is the same as in higher things, where, I suppose, our first imperfect conceptions gradually become more and more perfect, and we arrive at the knowledge of that which is useful to us, body, soul, and spirit. That may be the usefulness of the copper-zinc couple, as far as theory is concerned; but, as far as practical purposes are concerned, it has already enabled us, as you see, to make at least some half-dozen new substances, which we have now at our disposal. It has also afforded us an easy means of preparing a great number of other substances, such as these hydrides. It has been employed in one way in analysis. One of the most difficult problems in all analysis, but one which is very important too, is the estimation of nitric acid or nitrogenous substances in potable water—for instance, in river water. A great deal has been written on that subject, and Professor Thorpe has employed our copper-zinc couple for turning the nitric acid into ammonia. We have performed the experiment here. This is some of the nitrate of potash which was employed, and here is some ammonia which has been distilled from it after being acted upon; and here is some of what is called the Nessler's test solution. I will show you that this nitrate of potash will not affect the colour of the test in any way; but, if I take a little ammonia, we shall find a very great change. I have not tried whether I have really got any ammonia in this vessel. Yes, we have a quantity of ammonia, formed by the decomposition of that nitre by means of the copper-zinc couple.

I hope that I have been able in this short time to give you some idea of the principle of this copper-zinc couple, and of the work that is being effected in your laboratory by means of it. I trust that the work will go on, and that we may be able to illustrate more fully in this way several principles which I have had so much pleasure in bringing before you during this course of lectures "On Chemical Force."

CAUSES OF DESTRUCTION TO WOODEN POSTS.

By M. BOURSEUL,
Sub-Inspector of French Telegraphs.

Under the influence of air, asd sheltered from moisture, wood experiences a superficial alteration and assumes a deeper tint; it oxidises, and burns, but the action is extremely slow. Under water at great depths, withdrawn consequently from the action of atmospheric air, wood may be preserved for ages. In order that it experience a rapid alteration, it must be exposed to the simultaneous action of air and water.

When the air is in excess—that is, when the wood, maintained in a damp condition, is exposed to the air—the deterioration it undergoes is called *dry rot*. The non-nitrogenous materials of the wood comprise carbon and the elements of water. The hydrogen of the wood combines with the oxygen of the air, and some oxygen and carbon likewise break away under the form of carbonic acid. The residue is a pulverulent material called *humus* or *mould*, black or brown, and of a variable composition according to the nature of the wood which has produced it.

If, on the contrary, water is in excess—that is to say, the wood being well soaked, the air acts upon it, but without having free access to it, as happens near the surface of the soil when the wood is buried in a pervious and very damp ground—the decomposition takes the name of *wet rot*. In this case the elements of the water enter into combination with those of the wood, as well as with a small quantity of the oxygen of the air. A portion of the atmosphere's oxygen and the wood's carbon break away together, as in the previous case, under the form of carbonic acid. The residue is a whitish, soft matter, easily cut, but remaining whole and compact: this is the white decay.

There is another cause of deterioration. The wood comprises a quantity, more or less, of nitrogenous matters: these, when they are maintained perfectly dry, do not alter, but under the influence of moisture and temperature they become decomposed. The water does not here serve simply as the means to favour molecular move-

ment; it acts by virtue of the affinity of its elements for organic substance. Nitrogen, whose compounds are very unstable, tends to separate itself directly the substance of which it forms a part has ceased to partake of organic life; it unites itself to the hydrogen of the water and yields ammonia. In addition, the carbon unites itself to the oxygen, and becomes disengaged as carbonic acid. There is thus a double affinity; two altering-causes act at once so as to produce a very rapid metamorphosis. The wood in this instance is destroyed by *putrid fermentation.*

Thus three principal and distinct causes conduce to destroy wood:—

1. Dominating action of the air: producing a veritable combustion of the wood.
2. Dominant action of water.
3. Metamorphosis of the nitrogenous substance: the wood ferments.

If the above data are exact we recognise the question of the preservation of wood to be a complex problem, and one which is far from being fully solved. If, besides all the particular causes which lead to the destruction of woods, there exist general and well-marked causes of deterioration, one may ask if it be possible to front them with one sole remedy applicable in every case? May we hope that a substance injected into the pores of the wood will preserve it in a complete manner; and, supposing we can thus stop *fermentation*, will the wood be guarded against *dry* and *wet rot?*

Of the three causes of rot which have been enumerated each of the two first may exist alone. Suppose that by the injection of any substance whatsoever—sulphate of copper or tannate of iron—the nitrogenous matter is coagulated so as to form insoluble compounds resisting repeated washings; that will not hinder the *lignin* and *cellulin* from oxidising or combining with the elements of the water, according as the wood is found in the conditions favourable to *dry* or *wet rot.* This fact is perfectly established by direct observation. Let a post be injected (no matter how); if it be planted in a ground that is kept damp by limestone materials, and is broken up by sand which renders it pervious to air, it will be preserved from fermentation, but it will, nevertheless, be destroyed with one or the other rot with more or less rapidity.

On the other hand, if the wood suffer *putrid fermentation* it becomes rapidly disorganised; hence the non-nitrogenous portions do not delay to rot themselves. The third cause of destruction then combines always with one or the other of the two first, and it is that which oftenest attacks unprepared woods.

Dry rot produces first of all a brownish stain, extending principally in the direction of the wood's fibres, and also in a transverse direction, but much less extensively. This stain gradually penetrates from the surface to the heart; then the surface becomes disaggregated; the mould, sometimes called *black decay*, is detached with the slightest provocation, and the wood is honeycombed; it looks as though it had been slowly wasted by fire.

Whilst this action takes place little by little, and the post may, under these conditions, stand for several years, *white* or *wet rot* acts with surprising rapidity. The residue in no way resembles that of dry rot. The tissue appears inflated with the moisture; it continues entire, and it shows a smooth surface, but is very easily cut. If the wood is not cut into to determine its real condition, one would conclude its consistency and solidity to be perfect.

Whenever wood is attacked by *wet rot* a special kind of fungus is at the same time developed.* For pine and fir this fungus belongs to the merulian species, and is known to botanists under the name of *Merulus destruens* or *lachrymans.* When this vegetable encroaches upon a post it shows itself first on the north side, in the dampest portion and on the part *least exposed to light.* It runs up from the ground along the wood in the shape of filaments of great whiteness, which introduce themselves into the slightest crannies of the post, develop and spread into all the spaces they find in the neighbouring ground, under level stones, and in the open intervals often met with between the wood and the soil. These filets unite, assume firmness, and soon form a soft white surface, which adheres tenaciously to the wood. In this state it secretes small drops of a limpid colourless liquid, which gives its name of *lachrymans*—weeping. It is possible that this liquid, which gives a slight acid reaction, helps to render soluble certain parts of the wood at the expense of which the fungus is nourished. However that may be, under the whole surface covered by the *Merulus* the wood is found soaked to a great depth. Moreover, this fungus very readily absorbs the moisture of the air, especially that of the soil, and fixes it, so to speak, in a permanent manner upon the post.

When the *Merulus lachrymans* arrives at maturity it assumes a bright red colour, due, no doubt, to the presence of sporules which appear on its surface. These seeds, of very great tenuity, penetrate with facility into the slightest fissures in the wood, and, if they meet with conditions favourable to fructification, the wood is soon invaded by innumerable germs of destruction.

In the completely developed state the *Merulus* takes a round or oval form, of 25 to 30 c.m. in circumference. I found them for the first time in this condition on the Orleans Railway to the north of Toulouse, and was at first astonished to see the fungi arranged in parallel and equidistant lines. Searching for the cause of this regularity, I ascertained that the lines corresponded with the sleepers of the rails, most of which were thoroughly rotted.

The fungus is very rarely found in a mature condition on telegraph-poles. The ravages are principally produced by the vegetable under the form of *mycelium,**—*i.e.*, by those white and silken filaments previously referred to. These filaments burst the fibres of the wood by first implanting their most slender extremities into its narrow slits, then by developing themselves, and, finally, little by little spreading throughout the whole ligneous mass.† The *mycelium* seems to grow and extend at all seasons, and develops itself in depth (and especially in a horizontal direction) with very great rapidity. If the nature of the ground adapts itself, and if a sufficient quantity of dead wood be found under the soil, it is not rare to find—during the space of one year—the *mycelium* propagated for more than a metre in distance. It descends in a vertical direction so long as vegetation is possible, or wherever it finds a soil at once moist and permeated with air.

It may be asked if it is truly the fungus which brings about this destruction, since it may be claimed that the vegetable is only developed on the wood when it is attacked with rot.

It is very probable that rot always pre-exists, because if there were no commencement of alteration in the wood the spores or mycelium, as the case may be, would not find conditions suitable to their development. But the fungus, on the other hand, rapidly increases the rot which favours its existence, and thus they together accelerate one another in the common cause of destruction. In this manner the amazing speed with which the wood is destroyed is explained. It is hardly necessary to add that the injection of sulphate of copper does not by any means

* Acting on the information communicated to M. Roumeguère, of Toulouse, that gentleman studied the fungus that destroys posts. He has addressed two notes on this subject to the Botanical Society of France, which have been inserted in that Society's *Bulletin* (vol. xviii., 1871).

* *Mycelium* is the filamentous body from which a fungus or mushroom is developed.

† This fact is not, however, special to the fungus which now occupies our attention. I have often found the dead wood of posts invaded by radicles—notably by those of the *quitch-grass.* On carefully opening, in the direction of its length, a piece of wood attacked with *wet rot*, I have often seen that these *quitch-grass* radicles which had insinuated themselves into a slit had become developed in the dead wood, and had pushed aside the fibres so as to leave their imprint perfectly moulded.

preserve posts from this species of destruction. On the Midi Railway, between Toulouse and Montauban, where the line approaches a canal, injected posts were attacked by the *Merulus destruens*, and rendered useless in less than six months.

Hence we have to deal with a very dangerous enemy. The *Merulus* vegetates on living pines and firs; spores or mycelium may be lodged in the interstices of the wood; and for this reason, in planting posts, we bury with them germs of destruction which, in other instances, are found beforehand in the soil itself or are conveyed by the air.

(To be continued).

THE TELEGRAPH IN CHINA.

Some time since, the Chinese Government opened negotiations with the Great Northern Telegraph Company, of Copenhagen, for the establishment of three telegraph lines, which were considered necessary for defensive purposes on account of the invasion of the Island of Formosa by the Japanese. The lines were to unite—(1) Foochow to Taè-ouau-fau, the capital of the island of Formosa; (2) the north and south of the island; (3) Foochow to Amoy. A treaty was signed between the Governor of the Island and the Company, but it was not ratified by the Chinese Government. It was a matter of primary interest to the Company that the port of Foochow, the greatest *entrepôt* of teas from China, should be put into direct communication with Amoy, and consequently with England. They therefore solicited the concession of the third line. At this time the Japanese were occupying all the territory of the Island of Formosa, and were menacing the coast of Fokien. The Mandarins could not organise the defence without asking help from Europe. The proposed line would give them every facility in this respect, so they authorised the erection of the line from Foochow to Amoy, and they appointed a Mandarin from the Committee of European Affairs at Foochow, whose mission it was to announce the arrival of the *employés* of the Company, and to secure them a friendly reception. Shortly after, the Mandarins announced that the Chinese population was not hostile to the new enterprise. The negotiations for the concession of the lines were then continued. The Company were desirous of working the line for a term of thirty years, after which it was to become the property of the Chinese Government. The latter reserved the option of re-purchasing the concession.

These conditions seemed to meet with the approval of the Chinese authorities, and the Company, believing in the final success of the undertaking, lost no time in bringing to Foochow the materials for the establishment of the line. The line was pushed forward as quickly as possible, and by about the 21st of January of the present year 50 miles of the line were finished. While the workmen were penetrating into the interior of the country, the agreement was presented for the signature of the Mandarins. They accepted the principle of the clauses; but, as they desired some modifications, another draft was drawn up. Fresh objections, however, were raised, and it remained unsigned.

Time went on, and the treaty of peace was concluded. A new President of the Committee of European Affairs was appointed, who refused to ratify the business engagements of his predecessor. The relations between the Great Northern Company and the Chinese authorities became less friendly, and the latter learnt that the Viceroy of the province had given orders to oppose the continuation of the works; the Company were accordingly instructed to destroy the 50 miles of line already established. Although these instructions were not conformed to, the work was interrupted, in order to see what attitude the Government intended to take. The latter abstained from touching the line themselves, and it was thought they had received instructions from Pekin on the subject. The Company had warned the Mandarins that it would claim an indemnity of 4000 francs a day while the work remained stationary. As the opposition of the Mandarins continued, the Company decided to go on with the work, but the workmen were stopped by force. On the 12th of February last the mob were let loose upon the property. In all civilised countries the wishes of the Government are enforced by an organised body of police or military, but in China it seems to be the custom, whenever the occasion arises, to employ a mob against foreigners and foreign property. The reason why this course is pursued in preference to the more legitimate one is obvious enough. In the event of an explanation being demanded by the foreign Government, what more easy than to ascribe the affair to the uncontrollable fury of the people. The object of attack was a watch-house belonging to the Great Northern Company, built on ground purchased by them in conformity, not only with the terms of the concession granted to them, but also with a special clause in the Danish treaty. Three of these houses were built on ground purchased by the Company, at intervals of ten miles. All these houses contained property belonging to the Company; they were looted, the European and native *employés* driven therefrom, and finally the buildings were demolished. The portion of the line already constructed was pulled down, and the wire, poles, &c., stolen by the mob, who declared, we are informed, that the authorities had given permission to them to take whatever they could lay hands upon.

Five days before this occurrence news had been received in England of the completion of the second section of the cable. It is, however, a fact of considerable importance, that European workmen were able to construct 50 miles of telegraph in one of the least civilised provinces of the coast of China without meeting with opposition from the native population. The Company have recently announced that an agreement was signed on the 21st of May by the Viceroy of the province of Fookien, charged with full powers by the Minister for Foreign Affairs in Pekin.

The conditions under which the settlement of the difficulties has been made are, we believe, to the following effect:—The Company have undertaken to properly construct for the Government an overland telegraph between Foochow and Amoy, and to commence the work not later than the 15th of August next. The Chinese authorities have agreed to pay the Company 154,500 dollars, in instalments at fixed periods. The Company is to work the line on account of the Chinese Government, and teach Chinese pupils the art of telegraphy. The Government guarantees to protect the material required for the erection of the line, and hold themselves responsible for any delay occasioned through the unlawful interference of the inhabitants or others.

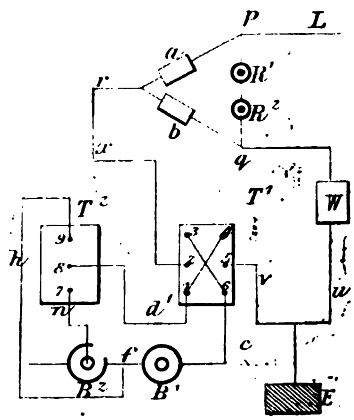
ON QUADRUPLEX TELEGRAPHY.

We are indebted to Professor Zetzsche for a paper on the subject of "Quadruplex Telegraphy." In it Professor Zetzsche quotes, from a work of his published in 1865 ("On Copying Telegraphs, &c."), by way of showing that the possibility of such telegraphing has been for some time in contemplation in Germany, an object both of theoretical inquiry and practical experiments. Of this the Americans seem not to have been aware.

Referring to Dr. Nicholson's method, he remarks that the three different strengths of current employed are in the same relation to each other as in M. Maron's system, only that the latter experimenter employs the current strengths $+S$, $-S$, and $-3S$. M. Maron also uses only one relay, but with *three* permanent magnetic armatures.

"Characteristically new, on the other hand," he proceeds, "is the way in which Prescott and Edison produce the three requisite strengths of current, inasmuch as they give to the line the constant current (Ruhestrom) $+S$, and use, in telegraphing, $-S$, $+2S$, and $-2S$. Of the key and battery arrangement for this, unfortunately, F. W. Jones

gives* no information. The arrangement which I have sketched in the annexed figure meets the conditions perfectly. In the state of rest of both keys, T_1 and T_2, the copper pole of battery B_1 is in metallic connection, through the working contact, 6, and the rest contact, 3, of the double key, T_1, with the key-axis, 2, and through the wire, *x*, with the angle-point, *r*, of the Wheatstone bridge, in whose diagonal, *p q*, the two relays, R_1 and R_2, are inserted; while the end-points, *p* and *q*, of the diagonal, are connected, on the one hand, with the line L, and on the other, through the rheostat, W, and wire, *n*, with the



earth. The zinc pole of this battery, again, is connected, through *f* and *h*, with the rest contact, 9, of the key T_2, with the key-axis, 8, and through the wire, *d*, with the working contact, 1, and the rest contact, 4, the key-axis, 5, and through the wire, *v*, with the earth, E. Both keys are furnished with contact-springs in such a way that the key-lever, immediately after the one spring has left the rest contact, is brought into connection, through the other contact-spring, with the working contact, and *vice versa*. If, now, the lever of the key, T_2, be pressed down, there will be introduced, besides B_1, the battery portion, B_2, through *n*, the rest contact, 7, and the axis, 8. At the other station, therefore, R_2 will answer to the increased positive current, while the tongue of R_1 will still remain in the position of rest. If, on the other hand, T_2 remain at rest, and T_1 goes into the working position, the copper pole of B_1 is connected through *c*, 6, 5, and *v* to earth, E; the zinc pole through *f*, *h*, 9, 8, *d*, 1, 2, *x*, and *r*, to the line L; whereupon, at the other station, both relays, R_1 and R_2, are actuated by the increased negative current, to indicate the signals given by both keys, T_1 and T_2.

Such an arrangement has a not unimportant advantage over the older ones, in that only two relays are necessary for the receiving apparatus. Along with this advantage, however, the arrangement has two drawbacks. For, at the transmitting station, there occurs, at each movement of the key, during the suspense, an interruption (though ever so small) of the line, giving reason to fear a rupture of the signals; at the receiving station, on the other hand, when the key, T_2, is held down, and the lever of T_1 moved up and down, the relay, R_2, may not liberate its armature, although the current changes its sign. Unfortunately these two defects are of such a kind as (it is to be feared) to forbid the practical employment of this arrangement, which is the more regrettable, that the advantage of the method might warrant the hope that it constituted a further step towards the successful realisation of quadruplex telegraphy. The value of such a mode of connection, however, I regard as consisting, not so much in its making possible the simultaneous sending of four telegrams on one wire, as in the fact that through it a perfect solution of the problem of duplex telegraphing and of transmitting two messages in the same direction at once is afforded; inasmuch as, to each receiving telegraphist is furnished also a key for interruption, and to every transmitting one a receiving apparatus, with which he may be cut off from the station working with him."

* New York *Telegrapher*, May 1, 1875.

THE TELEGRAPH IN SENEGAL.

The Senegal service comprises three lines—the first going from St. Louis to Dakar, the second from St. Louis to Dagana, and the third from St. Louis to the Bar (Mouth of the Senegal).

Dakar Line.—This line is the most important: it is 126 miles in length; its direction is from N. to S.W.; it is constructed with a single wire of 3 m.m. It connects six offices—St. Louis, Gandiole, Betète, Mbidjem, Rufisque, and Dakar. The region it traverses is for the most part uncultivated, without any road, intersected by large and deep morasses, slightly undulating, with impenetrable thickets of palms and bushes of different kinds scattered over it. From Gandiole to Mbidjem the country is no longer under the dominion of the French: it was given back in 1870 to a native chief, on the sole condition that he would respect the telegraph line and the station of Betète, placed in the heart of his territory. The staff employed at each of the stations is as follows:—At St. Louis, the director of the service, an *employé* of the fifth class on the metropolitan list, a native assistant, a supernumerary, a superintending chief, and two native superintendents; at Gandiole, a military *employé* and two superintendents; at Betète, a military *employé* and two superintendents; at Mbidjem, a military *employé* and two superintendents; at Rufisque, a military *employé* and one superintendent; at Dakar, an *employé* of the fourth class on the metropolitan list, a head of the office, a military *employé*, a supernumerary, and two superintendents: total, 23 *employés*.

Dagana Line.—This unites with St. Louis by an important station in a commercial point of view, placed on the River Senegal: its length is 77 miles, and its direction from W. to N.E. This line serves four offices:—St. Louis, Lampsar, Richard-Toll, and Dagana. The office at Lampsar is closed for the time being. The country traversed by this line is under French rule: it is often inundated during the winter season by the swelling of the river. At Lampsar resides a superintendent; at Richard-Toll, a civil *employé* and a superintendent; at Dagana, a civil *employé* and two superintendents: total, 6 *employés*.

The Bar Line.—The length is nearly seven miles. It traverses a region intersected by morasses, and by the tributaries of the river; its direction is from N. to S. It unites to St. Louis the pilot-station placed at the mouth of the Senegal. A civil *employé* has charge of the office.

Staff.—These nine offices are supplied with the following staff:—A head clerk from the Metropolitan Administration, director of the service (M. de Chauvillerain); two *employés* from the Metropolitan Administration, one of whom is at St. Louis (M. Sainte-Marie Pricot), and the other at Dakar (M. Flusin); four *employés* of the fifth class, natives; seven military *employés*; a chief superintendent, and fifteen native superintendents. The native *employés* are recruited by means of examinations. The military *employés* are put, by the marine infantry, at the disposal of the telegraphic service: they receive instruction at St. Louis and Dakar, and they are then sent to the interior stations. The native superintendents form a very good staff, many of them having been in the service since its organisation, twelve years ago: they are well up in their duties, thoroughly disciplined, and capable of bearing the fatigues and privations of a journey on foot in this unhealthy climate.

Interior Service.—The offices are open every day from 7 to 10 o'clock in the morning, and from 2 to 6 o'clock in the evening. The offices at Lampsar and Richard-Toll were closed in 1873.

Tariffs.—Between any two stations 2 francs for twenty words; 0·50 fr. more for each fraction of five words. Between St. Louis and La Barre, 0·50 fr. for ten words; 0·05 fr. for each additional word.

	Francs.
The amount received for private despatches amounts to	9,925·85
The transmission of official despatches corresponds to a sum of	13,492·00
Total	23,417·85

The total number of messages transmitted during 1873 was 8531.

The stations of Gandiole, Betète, and Mbidjem, being distant from any centre inhabited by Europeans, have only very few messages.

Surveillance of the Line.—This service is very trying, especially during the winter season: the torrents of rain and the violent tempests overthrow the poles and break the insulators. Notwithstanding these difficulties, only three days' interruption have taken place during the year. The materials, including the poles, are carried on the backs of mules. Nearly all the disarrangements are caused by the fall of the poles, which the sandy soil will not retain firmly: there is no stone in the interior of the country to consolidate them, and the wooden *traverses* are soon rotted or nibbled by the Termites; fortunately, however, they do not attack the injected poles. Many poles are also destroyed by the fire which the natives set to the rank grass to clear their fields. The thunderstorms, notwithstanding their great electrical intensity, lead to no durable perturbation over the lines and in the apparatus. As to the disarrangements caused by malevolence, these are excessively rare. The blacks, very superstitious, fear to touch the line; they believe generally that it serves only to indicate to Europeans the road to follow in going from Dakar to St. Louis.

MR. C. E. SPAGNOLETTI'S NEW RAILWAY ELECTRIC SIGNAL.

By the adoption of Mr. Spagnoletti's electric signal, the labour and danger attending the present syetems of signalling would seem to be reduced to a minimum. It combines the present system of signals and block telegraph, and includes a locking arrangement of signals and points, together with a notice call to drivers on their approaching a signal. At present the best system of block telegraph only conveys a signal on a small and delicately contrived instrument from one signalman to another, who in turn repeats it by means of fixed signals to the drivers of trains; but the signals themselves are worked from one station to another by this electrical apparatus; thus enabling drivers, signalmen, and other *employés* to at once see the signals transmitted from the station in advance, and thereby preventing the possibility of any misunderstandings or errors—which may be occasioned in their transmission, either through negligence or forgetfulness. The advantages are—1st. Immunity from danger, inconvenience, and delay, should the signal wire break on account of frost, overstraining, or other kindred causes. 2nd. The prevention of the present uncertainty in the working of signals from contraction or expansion owing to variation of temperature. 3rd. Greater protection to life and property from errors or forgetfulness of signalmen. 4th. The means of placing signals in any position required, thus ensuring the driver a long and good sight of them. With the present system, a signal cannot be worked beyond a limited distance with safety, and a very lofty post has often to be erected, on high ground, on curves, and in cuttings, so that drivers may get a good view of it; such posts are, in heavy gales, frequently blown down, and should they fall across the line, the traffic is thereby endangered; they are also expensive, and their cost is added to by their having to be "stayed;" moreover, their lamps are at a great height and are consequently inconvenient to light. With this electrical signal, distance is no object, as it can be worked equally well at 100 miles as at 100 yards, therefore a shorter and less expensive post answers the purpose, and is more convenient, as it can be placed in any position, and at any distance required. The signal arm can be worked either by a man or by a "treadle;" in the latter case, the train itself puts it up and takes it down.

In cases where these signals are placed out of the sight of the men who work them, it is arranged that the signal arm shall indicate to the man who works it, on a small instrument fixed in his hut, its position, whether it is at "danger," "all right," or in an intermediate position.

The patent mercurial lamp indicator is also associated with this signal, and acquaints the signalman whether the light is burning or not. This instrument is so sensitive in its action, that the warm air in the lamp is sufficient to work it; the alternate actions are far more rapid than in those systems where the metal is made very hot by the direct action of the flame, and which require a longer time to cool, and consequently a longer interval to give an indication whether the light is "*in or out*."

It can be so arranged, with this electrical system, that a point or switch cannot possibly be opened unless the signal protecting the same is put to "danger," or any other signals necessary to protect the points or switches to be worked are brought into action. At junctions where two, three, or more lines converge into one, the admission of a train from one line by taking down the signal puts the signals controlling the trains on all the other lines to "danger," and "treadles" may be used at junctions, so that any train itself may perform this work.

On the Metropolitan railways, or similar lines, signalmen may be dispensed with, and "treadles" used in their stead; the signalmen could then be otherwise employed. On such lines the *modus operandi* would be as follows:—Let A, B, and C represent three stations. On a train leaving A it passes over a "treadle" which puts the signal to "danger" to protect it, and a bell is also rung at B as a signal of its approach; on arriving at B it there puts a signal up, takes the signal down at A, and rings a bell at C, and so on throughout its journey. On main lines of railway it is often necessary (owing to stations being far apart) to erect intermediate signal huts with the usual system of signals, and extra men have to be employed. With this system a "treadle" and signal for the up and down lines is all that is required, and the expense of building a hut and the employment of extra men is obviated. In order to check the working of such intermediate signals, a bell can be rung on the passing of a train from the station in the rear to the station in advance, so that the signalman may have notice of a train's approach, and when the train passes over the intermediate "treadle" and puts the signal up, it sends to the signalman at the station in advance an indication of its position on a repeating instrument fixed in his hut, and on its arrival also shows him when the signal is taken down. Such an arrangement places this intermediate signal simply in the position of a present distant signal out of sight.

If the absolute block is worked by this electrical signal, as above arranged, either by a signalman or a "treadle," *one* signal for each line at a station will be sufficient in lieu of the present *six*, viz.:—The two distant, two home, and two starting signals. The signal, when worked, requires no effort of strength, and for the present expensive frame of levers is substituted a miniature and inexpensive arrangement.

NOTES.

The New York *Journal of the Telegraph* reproduces from the *New York Tribune* an account of an electrical machine that reads notes and plays an organ with absolute correctness of time and touch, the only assistance given it by the operator being to feed in the end of a roll of music and start the machinery in motion. The score is written on a long roll of stout paper by cutting holes through it in the form of squares, or parallelograms. The reading instrument, which is about as large as a sewing-machine, is provided with a multitude of small brass fingers, each of which is connected by a wire with the pipe of the organ which it operates. The roll of music is fed in over a brass tube. When the fingers rest on the paper no electric current is transmitted, because paper is a non-conductor; but whenever they fall into the holes cut in it they touch the brass below, the current is transmitted, and the sound produced. The length of the note is governed by the length of the slit in the paper. A noiseless bellows-machine, run by wind conducted through a pipe from the organ, works the feeding apparatus. To aid in producing orchestral effects, drums, cymbals, bells, &c., are added to the ordinary pipe-organ, and operated by electricity in the same manner as the pipes. A greatly increased volume of sound and much richer harmonic combinations can be made by this instrument than it is possible for a single performer to produce upon an organ, in consequence of the fact that the performer has only his ten fingers, while the electrical machine has two hundred, and can strike as many notes at once as desired. All the notes on the organ that can be combined into a chord can be brought out together. On the evening of the 10th of June, at the Horticultural Hall, the overtures to "Semiramide" and "William Tell" were performed with pleasing effect. As the reading instrument is mechanically accurate, and the score correctly written, there were of course no false notes. It was obviously machine music, however, but machine music of the highest order, and might have been mistaken for the performance of a well-drilled but rather spiritless orchestra. The inventors, Messrs. Schmoele, hope soon to apply their device to a piano.

Rear-Admiral B. F. Sands, the Superintendent of the United States Naval Observatory, reports that a time-ball has been dropped on the roof of the Observatory daily at noon, and time-signals are distributed by the Western Union Telegraph Lines to a large part of the country at the same instant. By an arrangement with the Western Union Telegraph Company, the Mutual Life Insurance Company, of New York city, receive the time direct from the Observatory, and a ball will be dropped at noon from a staff erected upon the top of the building belonging to the Insurance Company, at an elevation to be seen from all parts of the city and harbour, by which the time of the city and shipping can be accurately regulated.

The Italian Government has contracted with the firm of Erlanger and Co. for the laying down and maintenance of a submarine cable from the continent near Orbetello to the island of Sardinia.

Mr. Geo. F. Milliken, manager of the Boston office of the Western Union Telegraph Company, writes as follows in reference to battery covers:—"I have now in the battery room a few cells without oil, with wooden covers—one with zinc, one tin. The metallic covers are made with a rim 1 inch wide, fitting the cell, but not too closely. The openings for the wires and the space round the rim are filled with paraffin and tallow. They were set up May 7th for use in local circuits, and now (June 24th), without a drop of water added to them, there is no sign of diminution, and all are clean and neat as at first. The wooden coverings were put on May 19th, and the cells look well. These covers can be made for less than the cost of oil, and are permanent."

Mr. John Pender, M.P., stated—at the meeting of the Eastern Telegraph Company—that the Suez and Aden section of the Company's cable has improved in insulation by no less than 38 per cent, and the other cables of the Company from 45 to 77 per cent. The cables longest laid have improved the most. All these cables have been laid by the Telegraph Construction Company.

The International Telegraph Conference at St. Petersburg was closed on Tuesday, the 20th inst. The President delivered a farewell address, in which he enumerated the results of the deliberations.

In 1872, when the telegraph wires were first extended to Lord's Cricket-Ground, the four principal matches of the year produced among them upwards of 800 telegrams, while in the year following the number rose to upwards of 1100. In 1874, when all of the matches were of exceptional interest, the number rose to 1300; but this year the increase has been beyond all precedent, as many as 1700 messages having been disposed of in connection with the three principal matches which have been played during the past fortnight. The Oxford and Cambridge Match having been prolonged over three days this year produced a total of 800 messages, as compared with less than 400 last year; while the Eton and Harrow Match produced upwards of 700, and, but for the adverse weather, must have yielded quite 1000. On the concluding day of the match, upwards of 500 messages were handed in for transmission at the travelling telegraph office, and on both days of the match as many as three columns of news for the press were disposed of in this curious post-office on wheels. The Telegraph Department has a very keen eye for business on such occasions, for, says the *Times*, messengers were stationed at convenient points within the grounds to collect telegrams from the public and run with them to the telegraph office; while the peculiar circumstances of the occasion had been so far considered that dwarf counters had been erected around the office for the use of persons wishing to write telegrams, but not tall enough to reach the ordinary counter.

Post-Office Telegraphs.—Statement showing the total number of messages forwarded from Postal Te

graph Stations in the United Kingdom during the week ended the 10th July, 1875, and during the corresponding week of 1874:—1875, 425,136; 1874, 397,238; increase in the week of 1875 on that of 1874, 27,898. Week ended the 17th July, 1875, and corresponding week of 1874:—1875, 445,294; 1874, 410,351; increase in the week of 1875 on that of 1874, 34,943.

CORRESPONDENCE.

ACTION OF THE GALVANIC CURRENT ON THE ORGANS OF SENSATION.

To the Editor of the Electrical News.

Sir,—In the report of the proceedings of the Physical Society contained in your valuable paper (Electrical News, vol. i., p. 8), I read an account of Dr. Stone's communication "On Subjective Sensations of Taste," in which, after satisfying himself that no zinc is dissolved by the saliva in the production of the "galvanic taste," the author states that, "it could hardly be referred to chemical action, but must result from direct stimulation of the sensatory apparatus," &c. I beg to refer that gentleman to my paper in the *Comptes Rendus* of the Paris Academy for Nov. 9, 1874, p. 1072, entitled "Action du courant électrique sur les organes des Sens," in which he will find that his conclusions have been anticipated.—I am, &c.,

T. L. Phipson, Ph.D.

London, July 11, 1875.

ELECTRICAL SCIENCE IN FOREIGN JOURNALS.

(This column is devoted to a list of Electrical Memoirs published in Foreign Journals. Those of importance will be either translated in full or given in abstract.)

Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences. Vol. lxxxi., No. 2, July 12, 1875.

Magneto-Chemical Phenomena Produced within Rarefied Gases in Geissler's Tubes, by Aid of Induced Currents.—J. Chautard.—I have previously presented two notes to the Academy of Sciences, whose objects were—(1) to specify the experimental conditions under which the operator should place himself to safely realise the modifications produced by the magnets upon the spectra of Geissler's tubes; (2) to point out the principal conclusions to which my researches led me. In all simple bodies which I have examined of the chlorine family and the gaseous or volatile compounds derived therefrom, the action of the magnet is immediate, and reveals itself, not only by a change of the tube's tint, but chiefly by a more complete illumination of the streaks which then appear with a marvellous brilliancy. The wave-lengths of each of these streaks have been measured with care, and will be embodied in another paper. The bodies upon which I experimented were, besides chlorine—bromine and iodine; the chloride, bromide, and fluoride of silicium; the fluoride of boron; chlorhydric acid; chloride of antimony, of bismuth; the bichloride of mercury; the protochloride of tin and its bichloride. The light from sulphur and selenium was in a moment completely extinguished when the magnet was excited, and so it was with the tubes of chlorine, bromine, and iodine, if the strength of the coil was suitable. The light of oxygen, though pale, underwent, nevertheless, no sensible modification, and so also with the carbon compounds, such as carbonic acid, oxide of carbon, proto and bicarbonated hydrogen. The fine bands of the spectra from nitrogen only underwent modifications in the red and orange portion. These colours were almost completely extinguished; or, at all events, were replaced by a tolerably uniform dull tint from which all trace of fluting had disappeared. As to the bands in the most refrangible part, they remained almost intact. The hydrogen rays preserve sensibly the same appearance; although by using a sufficiently energetic electro-magnet, a very brilliant yellow ray is seen, which is no other than that of sodium, and which evidently appears from the soda in the glass. The gas thrown upon the sides of the tube may perhaps either volatilise or reduce a small quantity of soda, whose presence betrays itself through the characteristic yellow line. This ray vanishes, as if by enchantment, when the current is broken, and reappears immediately the current recommences. In time this yellow line loses its intensity, and the tube requires several moments rest to permit it to reappear. It shows itself sometimes in nitrogen, carbonic acid, and chlorhydric acid tubes, submitted to the magnetic action. Crystallised and dry, but bihydrated, protochloride of tin offers one of the most remarkable phenomena of dissociation under the magnet's influence. In the normal state the spectrum is pale, and presents some of the green lines of chlorine; but immediately the magnet is excited, two of the characteristic lines of hydrogen are seen depicted—the red and the blue—which remain so long as the magnetisation lasts, and which ceases directly it is discontinued, and so on indefinitely. I can only interpret this phenomena by the momentary separation of the elements of the water of the salt on account of the considerable resistance opposed to the current's passage during the period of magnetisation.

On the Temporary Magnetisation of Steel.—M. Bouty.—I introduced needles into the magnetising helix during the current's passage, and I deduced the value of their temporary magnetic moment according to Wiedemann's method, from the deflection they produced upon a horizontal needle suspended from a cocoon thread, and furnished with a mirror. When the needles have all the same length, and when the length is sufficiently great with regard to their diameter, the determination of the magnetic moment may replace that of the quantity of magnetism. There are strong reasons for concluding that the distance of the poles from the extremities, in long needles, during temporary magnetisation, is independent of the current's strength, and that its constant value is that which permanently saturated needles present.* The experimental verification of this hypothesis is surrounded with grave difficulties which could not be completely dispersed in the unfavourable conditions in which I was placed; but I have at least been able to assure myself that the difference from the poles to the extremities during temporary magnetisation differs but little from its theoretic value, so that the results need not be altered. Let y be the temporary magnetic moment developed in a needle l long, by an exterior magnetic force x, acting in the direction of its axis: let also δ be the double distance of a pole to the adjacent extremity. According to the preceding hypothesis we have $y = A(l - \delta)$, whence we obtain at once, since δ is known, the value of A, the quantity of magnetism. The quotient of A by the section is a function of the intensity x of the magnetic force, which we should call *total magnetising function*, to distinguish it from the *function of permanent magnetism*. The conduct of the total magnetising function is nearly that which attracted attention in a former paper on the function of

* When a needle is placed in the axis of a sufficiently long magnetising helix, it is in a magnetic field of very sensibly constant intensity. Conformable with Green's calculations, the distribution of magnetism in saturated needles is that which would be produced in a non-coercive steel by the continued action of a constant exterior force acting in the direction of the needle's axis. Then the distance from the poles to the extremities during temporary magnetisation is the same as in needles of the same diameter permanently saturated.

permanent magnetism, and the curve which represents it, shows a deflection corresponding to almost the same value of x, and the limits of rapid permanent magnetisation agree also with the total magnetisation. Further, and though neither one nor the other of the two functions of magnetism have been represented by any simple empiric formula, their relation r is expressed in the case of our very hard tempered needles and the limits of the experiments, by a hyperbolic function of x—

$$r = 1{\cdot}3 + \frac{b}{(x-c)^2}$$

which is applicable to all needles of 0·5 m.m. to 1·5 m.m. diameter, and in which c is a constant that does not vary from one needle to the other, whilst the constant b seems united to the least variations of temper. I here give this relation, though it be not general, because of the convenience of its use in the study of temper. It does not apply either to very thin needles or to soft-tempered needles, but simply to the special limits as above.

Annales Telegraphiques, vol. ii., May to June, 1875.

Hughes's Apparatus.—M. Caël.—A paper of statistics advocating certain alterations for improving its speed of working.

The Pneumatic Telegraph.—Charles Bontemps.—Will be referred to in a later number.

Electric Standards and their Measure in Absolute Units.—E. E. Blavier.—Continuation of former papers on the same subject; and unsuited to our columns.

Derivations of the Current along Electric Lines.—Jules Raynaud.—A mathematical paper incapable of abstraction.

Induction Currents Produced on Telegraph Wires.—M. Lagarde.—Already translated, and will appear in full in a future number.

Vibrations of Receiving Mirrors.—M. Wanschendorff.—Also reserved for future translation.

Electro-magnet of Concentric Iron Tubes.—M. J. Camacho.—This is a descriptive note taken from the *Comptes Rendus* of 8th February, 1875. For particulars we refer our readers to page 2 of this journal, containing a paper by the Count du Moncel "On Tubular Electro-magnets with Multiple Cores."

New Source of Electricity.—M. Donato Tomasi says:—When a current of steam is made to traverse, under a pressure of 5 to 6 atmospheres, a copper tube of 2 to 3 m.m. diameter wound spirally around an iron cylinder, the latter becomes so strongly magnetic that an iron needle placed some centimetres away from the steam magnet is energetically attracted, and remains magnetised during the whole period of the steam current through the tube. (Taken from *Comptes Rendus* of April 19, 1875.) In continuation of this M. Maumené quotes the following observations:—The important experiment of M. Donato Tomasi should, it seems to me, be interpreted by a very different consideration from that of the author. Heat does not act so as to produce "a new source of magnetism." It produces a thermo-electric current, generating the observed magnetism, and is set up by the difference of temperatures between the interior surface of the copper spiral traversed by the steam and the exterior surface exposed to the air. M. Tomasi ought to be able to reverse the current, and consequently the poles, by causing the heat to act so as to warm the exterior surfaces, at the same time maintaining the interior surfaces colder. (Taken from *Comptes Rendus* of May 3, 1875.)

The Telegraph in China.—Embodied in the article on page 41.

The Telegraph in Italy.

The Conference at St. Petersburg.—Address of the Minister of the Interior.

The Telegraph in Senegal.—From the report of the director, M. de Chauvillerain. See page 42.

Bulletino Telegrafico, Anno. xi., May, 1875.

The non-official part contains observations on the skull of Volta made by C. Lombroso, professor of the clinic of mental maladies at the University of Pavia. He calculates that the brain must have weighed 2055 grms., an amount exceeding that of Cuvier (1829), of Byron (1807), little inferior to that of Cromwell, and surpassing the ordinary Italian average brain by 440 grms.

Comparison of Electrical Machines.—

Machine.	Diam. of Disk. Metres.	Strength of Current in Electro-Magnetic Measurement.
1. Ramsden	0·97	0·0000222
2. Ramsden	1·62	0·0000378
3. Ramsden with insulated cushions	0·98	0·0000222
4. Van Marum	0·84	0·0000311
5. Nairne (cylinder)	0·32	0·0000060
6. Holtz, 1st kind (Ruhmkorff)	0·55	0·0001000
7. Double do.	0·55	0·0001900
8. Holtz, second kind (simple current)	0·30	0·0000511
9. Carré, ebonite disk.. ..	0·50	0·0000333
10. Armstrong	—	0·0000533
11. Induction machine	—	0·0002889
12. Holtz, second kind (double current	0·44	0·0001282
13. Double, Poggendorff ..	0·42	0·0001265

The unity of electro-magnetic measurement is a little greater than that of Jacobi.

The remaining articles are translations from the English.

Journal de Physique, June, 1875.

Note on the Pressure of Electricity and on Electric Energy.—M. Blavier.—Hardly suited for abstraction.

On the Flow of Liquids.—M. Isarn.—The author shows, by some experiments, that in the phenomenon of contraction of a liquid vein, one cause is, superficial tension acting like an elastic ring round the jet where it quits the vessel. In one experiment he varies the superficial tension by action of electrolysis. A vein of mercury is made to flow through a narrow tube which is immersed in acidulated water, connected with one pole of a battery, while the mercury is connected with the other pole. With suitable pressure, the flow being *nil* in normal conditions, it appears either in drops, or with a limpid portion when the current passes so that the vein is positive. On breaking the circuit, the flow ceases, as if one had turned a cock. Again, if the liquid already flow with a limpid portion, this portion is suddenly elongated when the vein becomes positive. Lastly, if the vein be made negative, the phenomena are reversed, so that the limpid portion contracts successively, in the passage from + to zero, and from zero to −; and we may have continuous flow when the vein is positive, flow by drops when it is in a neutral state, and complete cessation of flow when it becomes negative. These phenomena show that the positive mercury, *i.e.*, oxidised superficially, has a weaker superficial tension, and that this tension returns to its normal value when the mercury is deoxidised. M. Isarn has noticed the same thing in the sinking and rise of an areometer plunged in mercury, when the surface of the latter, covered with a layer of acidulated water, is made successively positive and negative by the passage of a current.

On the Hughes' Electro-magnet, and some of its Applications.—M. Lartigue.—Will appear in a future number.

Poggendorff's Annalen der Physik und der Chimie, No. 5, 1875.

Mode of Demonstrating the Extra Current Electroscopically.—Dr. Fuchs.

Electric Resistance of the Air.—M. Oberbeck.—Reserved for separate note.

Changes of Temperature which Occur in Passage of the Electric Current from one Metal to Another.—M. Buff.—Reserved.

Isodynamic Surfaces about a Vertical Magnetic Bar, and Application of them in the Search, based on Magnetic Measurements, for Deposits of Iron Ore.—M. Thalen.—Already noticed elsewhere.

Form of the Isodynamic Surfaces about a Vertical Magnetic Bar.—M. Daug.

Attraction and Separation-Time of the Electro-magnet.—Dr. Schneebeli.—The author's *resumé* is as follows:—(1) The branches in telegraph lines not only diminish the strength of the current which reaches the other station, but also delay the manipulation of the receiving apparatus; (2) these delays are produced by extra currents; (3) in bad weather the delays arise from diminution of the resistance which the extra current has to overcome; (4) the branches are the more prejudicial to telegraphy, the less resistance they present, and the nearer they are to the receiving apparatus; (5) the extra current not only delays the attraction of the armature, but also the moment at which the armature is lifted by the spring.

Mathematical Determination of the Places of Leakage on Telegraph Lines.—M. Schaak.

Sitzungsberichte der Kaiserl. Akademie der Wissenschaften, Bd. lxx., Heft 4 and 5.

Laws of the Magnetic and Electric Forces in Magnetic and Dielectric Media, and their Relation to the Theory of Light.—M. Stefan.—Reserved for separate note.

The Journal of the Telegraph, Vol. viii., No. 11, June 1, 1875.

The Quadruplex Patent Case.

No. 12, June 15, 1875.

Electro-Magnetism and Electro-Magnetic Induction.

Mechanical and Electrical Tests of American Iron Wire.—George B. Prescott.—A summary of the results of a series of tests upon four samples of galvanised wire, the sizes being among those commonly used in telegraphic communication.

	Mechanical.						Electrical.	
Sample Mark.	Weight per Mile (lbs.).	Breaking Strain (lbs.).		Per Cent of Elongation.	No. of Twists (6 in.)		Per Cent Conductivity Pure Copper = 100.	Resistance per Mile Ohms at 60° F.
151	282·8	780, 760	770·0	10	25, 28	26·5	21·9	16·1
146	287·5	825, 840	832·5	16	37, 31	29·0	21 6	16·1
A H	293 5	1260, 1255	1257·5	15	28, 27	27·5	15·1	22·7
443	378·1	1640, 1630	1635·0	10	29, 33	31·0	16·5	16·1

The above results seem to point to one very interesting, as well as important, fact, viz., the close relation existing between the tensile strength and the electrical resistance of iron wire. It will be observed that the first three samples tested are of nearly the same gauge or weight per mile, the size being that usually designated as No. 9½. The tensile strength, or breaking strain, of the third sample is some 50 per cent greater than that of the first two, while its special electrical resistance is also comparatively very high. The proportionate tensile strength of the last two samples is very nearly equal, and so also is their proportionate conductivity, as compared with pure copper, as shown in the sixth column of the table. There seems to be no apparent relation existing between the conductivity or tensile strength of the several wires, and the percentage of elongation, or the number of twists that a given length will sustain before breaking. The high conductivity of the first two samples is very remarkable. The conductivity of iron is generally assumed by the best authorities to be one-seventh that of pure copper, or about the same as that of the third sample, but it will be observed that the first two samples have a conductivity averaging nearly 22 per cent that of pure copper. Thus, the first samples (No. 9½), weighing but 282·8 lbs. per mile, actually has as much conducting power, mile for mile, as the fourth sample (No. 8), weighing 378·1 lbs. per mile.

No. 13, July 1, 1875.

The Gold and Stock Telegraph Company's Private Line System—Gray's Printing Instrument.—In 1871, the Gold and Stock Telegraph Company decided to purchase or control all the most valuable patents for printing instruments adapted to private lines. By erecting a sufficient number of lines to meet the probable requirements of the business, the Company were able to connect any required points within the range of their field of operations. Thus they could supply at short notice a complete telegraph line, and, by means of a trained corps of efficient *employés*, they could assume the entire charge of it at a moderate rental. One of the most extensively used instruments for private lines throughout the United States is Gray's automatic printer, of which an illustrated description is here given.

The Line Galvanometer.—The Voltameter.—An illustrated description of these instruments.

The Sixth Cincinnati Exposition.—This Exposition will open to the public on Wednesday, September 8th, and continue until Saturday, October 9th. This year the managers have decided to form a distinct class of the electrical and telegraphic apparatus and supplies, and offer no less than thirty-five premiums to exhibitors of this class of machinery. The following is the list:—

Gold Medal.—Best System for Simultaneous Transmission of Two or more Messages over Same Wire (in operation). For Automatic Telegraphy (in operation). For Fire Alarm Telegraphy (in operation).

Silver Medal.—Best System for Private Line Telegraph (in operation). For Transmission of Musical Sounds by Electricity. For Automatic Fire Alarm Telegraph (in operation). For Telegraphic Railway Signal. For Adaptation of the Telegraph to Domestic Use. Best Fire Alarm Signal-Box. Display of Instruments and Supplies. Instrument for Quotations. Electric Engine, Motor for Light Work. Telegraph Set (Key, Sounder, and Relay). Electric Magnetic Motor. Magnetic Watchman's Clock. Printing Instrument for Private Line. Dial Instrument for Private Line.

Bronze Medal.—Best Galvanometer. Telegraph Battery. Electric Light. Electric Hotel Annunciator. Box Relay, Key attached. Pocket Relay Magnet. Morse Register. Single Cut-Out. Switch for from Four to Twenty Wires. Coil Wire. Sample Office and Magnet Wire. Submarine Cable. Air Cable. Amateur Instrument Insulator. Electric Gas-Lighting Apparatus. Burglar Alarm. Electric Clock.

THE traffic receipts of the Anglo-American Telegraph Company on the 13th inst. were £1420, on the 14th £1450, on the 15th £1430, on the 16th £1420, on the 17th £1460, on the 18th £320, on the 19th £1290, on the 20th £1330

COMMERCIAL NOTES.

A SPECIAL meeting of the Western and Brazilian Telegraph Company will be held to morrow (Friday) for the purpose of authorising the raising of additional capital to the amount of £45,200. The traffic recipts for the three months ended June 30 have amounted to about £31,000, and would justify the payment of the usual dividend, but the Directors have, upon the Auditors' recommendation in the last annual report, and in consideration of the cost of the repairing ship being still unpaid, &c., passed the quarter's revenue to a reserve account.

A general meeting of the members of the Société du Cable Transatlantique Français, Limited, will be held on August 5 for the purpose of receiving an account of the liquidations, showing the manner in which the winding-up has been conducted, and the property of the Company disposed of.

The East Indian Telegraph Company announce that the bonds falling due on August 10 will be paid off at the Bank of England, as provided for on each bond, and in order to replace them the Board will shortly raise by tender £1,000,000 on 4½ per cent debentures.

At the half-yearly general meeting of the Telegraph Construction and Maintenance Company, Limited, held on Tuesday, at the Cannon Street Hotel, Sir Daniel Gooch said that the work they had had in hand during the present year had been very small. In the course of a few days, however, he hoped the Company would conclude a contract for a cable, 1380 miles long, from Sydney, New South Wales, to New Zealand, and he trusted that for the rest of the year they would be well employed. They knew of no other work like the one he had mentioned coming forward, but they were quite prepared to take work should it present itself. He did not think it was unfortunate, even for them, that there should be a cessation for some time in the construction of these long cables. He thought this work had gone on now for some time, and with a little rest he hoped the existing cables would remunerate their shareholders better than they had in the past.

The *Times* of yesterday states that the capital stock (Consols) created in respect of money raised for the purchase of post office telegraphs, &c., amounts to £9,790,198. The sum of £293,706 was required to pay the interest on that amount for the year 1874; but the year's surplus of receipts from the telegraphs was only £109,161, or £184,545 less than the interest payable, and there was a previous deficiency of a like kind amounting to £288,607, so that the accumulated deficiency of telegraph revenue to meet the interest on the capital amounted to £473,152 at the end of 1874. The deficiency was really larger, as there are some telegraph charges borne by the Office of Works, or not yet exactly ascertained.

We announced in our last issue that the directors of Hooper's Telegraph Works had decided not to pay an *ad interim* dividend for the first half of the present year. On Tuesday an extraordinary general meeting of Hooper's Telegraph Works Company was held, with the view of altering the regulations of the company, to enable them to increase their borrowing powers. Mr. Dunlop, the Chairman, said the object of the meeting was to remove the restriction on borrowing in the articles of the association, and to enable the directors to borrow £150,000 on debentures. He was authorised to state that Mr. Hooper would relinquish his portion of the profits for five years if they consented to alter the regulations and raised the money proposed to carry out certain new contracts. His proportion of the profits had heretofore averaged £27,500 a year, so that, after paying the interest on the debentures, the company would obtain a clear gain of £17,000 a year by the arrangement. He moved a formal resolution to the effect that the regulations of the company be altered by striking out the words in the 37th clause of the articles of association of the company beginning at the word "provided" and ending with the words "paid up." The resolution was seconded by Mr. Grenfell. A short discussion ensued, in the course of which it was stated that the capital of the company was £250,000, and that £286,000 was invested in works and steamships. To meet the interest, &c., on the extra capital Mr. Hooper would relinquish his share profits for the next five years, which averaged £27,451 per annum for the past five years, but would retain his salary as managing director. Under the original arrangement with Mr. Hooper he was entitled to half profits over 7½ per cent dividend on the capital, and no doubt it was a very liberal concession on his part. Mr. Hooper said he was the largest shareholder in the company. Their cables were second to none, and the last two cables were the best cables ever laid. The resolution was carried. The Chairman stated that he was sorry they had not an interim dividend to give the shareholders for the half-year ending the 30th of June last. He added that unless the whole of the £150,000 was raised Mr. Hooper would not be bound to give up his share of the profits.

TELEGRAPH SHARE LIST.

Amount per Share.	NAME OF COMPANY.	Amount paid up.	Closing Quotations.
£		£	July 21.
Stock	Anglo-American	100	62¾—63¼
10	Black Sea	All	2—4
10	Brazilian Submarine	All	6¾—7¼
10	Cuba	All	8¼—8¾
10	Ditto, 10 per cent Preference ..	All	13¾—14
10	Direct Spanish	9	4¾—5¼
10	Ditto, 10 per cent Preference ..	All	10¾—11¼
20	Direct United States Cable	All	8—8½
10	Eastern	All	7—7½
..	Ditto, 6 per cent Debenture	..	103—106
10	Ditto, Exten. Australia and China	All	7⅛—7⅞
10	German Union Telegraph and Trust	All	8—8½
10	Globe Telegraph and Trust	All	5¾—6¼
10	Ditto, 6 per cent Preference	All	10¼—10¾
10	Great Northern	All	9½—10
25	Indo-European	All	19—21
10	Mediterranean Extension	All	2¾—3¼
10	Ditto, 8 per cent Preference	All	10—10½
10	Panama and South Pacific	2½	..—..
8	Reuter's	All	9½—10½
Stock	Submarine	100	200—210
1	Ditto, Scrip	All	1¾—2
10	West India and Panama	All	2¾—3¼
10	Ditto, 10 per cent Preference ..	All	9½—10½
20	Western and Brazilian	All	13—13½
1000 dls.	Western Un. U.S. 7 per cent 1st M.B.	All	106—108
100	Ditto, 6 per cent	All	89—90
10	Hooper's Telegraph Works	All	8—8½
50	India-Rubber and Gutta-Percha ..	All	18—20
Cert.	Submarine Cables Trust	100	95—99
12	Telegraph Construction	All	24—25
100	Ditto, 7 per cent Bonds	All	100—104

NOTES AND QUERIES.

Electricity and Incrustation.—Can any of your readers inform me of the most simple and cheapest means of keeping up a constant electric current in the water of a steam-boiler, either by a machine, a liquid, or solid, to remove and prevent incrustation in boilers?—THE ANXIOUS.

TO CORRESPONDENTS.

*** Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which "THE ELECTRICAL NEWS and TELEGRAPHIC REPORTER" is the organ, will always command attention. Literary communications and books for review should be addressed to the EDITOR; business communications to the PUBLISHER, Boy Court, Ludgate Hill, London, E.C.

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THE ELECTRICAL NEWS

AND

TELEGRAPHIC REPORTER.

EDITED BY WILLIAM CROOKES, F.R.S., &c.

TO ELECTRICIANS EVERYWHERE.

Since the day when Electricity was first discovered, until now, its vast importance and its high destinies have grown upon the human mind. Fresh phases of its power, fresh results, new means of obtaining and governing its action, and multiplied ends to which it may be turned, have constantly discovered themselves; till to-day it stands out as one of the grandest subjects presented to the scientific and practical world for investigation and research. Perhaps, however, no other Science or Art has exhibited so extraordinary a concurrence of anomalies. It is at once the most terrible monster and the most humble and obedient servant, its action is at one moment beneficial, at the next destructive; its range is boundless, yet it may be "cabined, cribbed, confined" at ease; it is everywhere present, while its nature is only imperfectly understood; and, to crown all, although it is one of the most important agents in the action and the phenomena of the universe, and increasing knowledge of its applicability to the needs of our race is of the utmost importance, no direct means of ascertaining the thoughts and discoveries of its students, or of bringing them before the scientific and mechanical community, at present exist. Attempts have been made to supply this want, and journals have been started with the professed object in view of making public all that is known or can be learnt of Electricity in all its branches. But they have degenerated into unscientific records of unimportant events, and the purpose for which they were established has been lost sight of. Thus it comes that—while Engineering, Chemistry, and other Applied Sciences have all their representative recognised organs—the Electrician finds himself without any current journal from which he can learn the events which are daily occurring of peculiar interest to himself.

Such a want has now been supplied by the establishment of the Electrical News and Telegraphic Reporter. In its columns will be found the most valuable opinions of eminent Electricians and scientific men all over the world. Articles will be contributed which will be of value not only to those who study Electricity as amateur experimentalists or scientific inquirers, but also to those whose daily life is bound up with the advancement of practical knowledge in all departments of the science, and who as electricians, telegraphists, electrotypers, electroplaters, and chemists have continually to deal with the same marvellous agent of force in different ways. Nor will the doings of foreign societies be ignored as in times gone by, but, in the shape of carefully prepared abstracts, their proceedings will be presented to our readers. Every opportunity will be given for the healthful discussion of the science in all its branches, and a fair unbiassed course will be steered in all questions of dispute.

This, then, is our Programme in brief. More we could promise, but prefer to let the new periodical speak for itself. The subject with which it will deal is of too great importance to need one word of recommendation. Daily experience teaches us that we are as yet on the threshold only of a vast expanse of electrical knowledge. This has to be explored, and as the research gains in strength and intelligence the results will be far beyond all present conception. The feat of girdling the earth in forty minutes will be eclipsed by great deeds yet to be done, and if the establishment of the Electrical News and Telegraphic Reporter conduces to the hastening of this desirable end our object will have been gained, and we shall be fully rewarded.

Boy Court, Ludgate Hill, London, E.C.
July 1st, 1875.

London: Printed and Published by the Proprietor, William Crookes, at the Office, Boy Court, Ludgate Hill, E.C.
July 22, 1875

THE

ELECTRICAL NEWS

AND

Edited by Wm. Crookes, F.R.S., &c.] TELEGRAPHIC REPORTER. [Registered for Transmission Abroad.

Vol. 1.—No. 5.] Thursday, July 29, 1875. [PRICE, 4d. POST FREE, 4½d.

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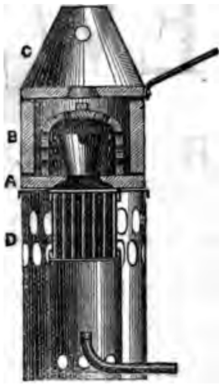

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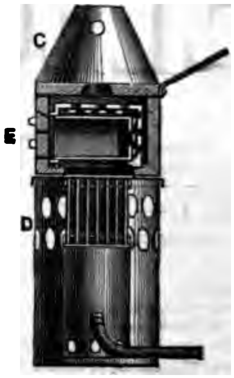

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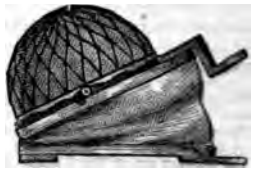

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E ELECTRICAL NEWS.

VOL. I. No. 5.

ON THE

RUCTION OF WESTEND CHURCH SPIRE BY LIGHTNING.

By J. W. CLARK.

ıG a heavy thunderstorm, on the 12th of June, the of Westend Church (about 5 miles out of South- n, and situated on elevated ground) was struck by ing, and being without a conductor a large portion hrown down, whilst the remainder of it was so ;ed as to necessitate its subsequent removal.*

shape the spire was an octagonal pyramid, 58 feet with sides 8 or 10 feet wide at the base, and com- of brick covered with cement. The summit was ucted of four pieces of stone, each about 1 foot which were cemented together to give additional :th. There was also an iron bar, ¾ of an inch square bout 6 feet long, running down through their axis, ɔwer end of which was firmly imbedded in the first surmounting the brickwork of the spire, whilst the end similarly terminated in the top stone, where it :overed with 4 or 5 inches of stone and cement. spire stood on an uncemented white brick tower, t square and 46 feet high, so that the entire height the ground to the summit of the spire was 104 feet. : tower was situated at the south corner of the rn end of the church, and thus it was that the h escaped uninjured, with the exception of a few which were broken by the falling *débris*. On each r of this tower stood a stone pinnacle, some 4 or : high, which had small stone ornaments fixed on the y means of an iron bolt (technically a dowl), and :ly imbedded in the masonry. When the lightning k the summit of the spire it broke the stone covering ɔp or upper end of the iron bar, leaving 4 or 5 inches exposed, but it showed no appearance of fusion, nor the lead which had been used in fixing the bar into ɔp stone. It also stripped off all the cement covering op 5 or 6 feet down, and separated that joining the s together, so that they were kept from falling only e iron bar, which was firmly fixed in a large stone; t was bent at an angle of about 45° in a south- :rly direction. It was the side towards which it was ıed that the most damage had been done, both to : stones, to the tower, and to the spire itself. Fully hird of the spire was knocked out, but the bell and :inc floor of the belfry the lightning left apparently : untouched. From the spire it seems to have leapt ı the pinnacle situated on the south-west corner of ower, breaking the stone ornament, and knocking it the corner of the tower upon which it stood to the nd, leaving the remainder severely cracked and .en.

ıe appearance of the damaged spire was remarkable. ınd down the sharp angles formed by the faces of the midal spire meeting, the lightning had cut long strips ıe cement, 6 or 8 feet long, and in some places appa- ly more or less affecting the brickwork below it, and :h were held up only by their resting upon the ends of lar pieces lower down. The areas between these es were comparatively unaffected.

hat great force must have been in operation was evi- :, inasmuch as, besides the damage already described, iece of stone weighing about 14 lbs. was thrown yards, and the ground around the tower was strewn ı fragments, many of a large size.

* An account of the skilful manner in which this was accomplished appeared in the *Times*.

THE HUGHES ELECTRO-MAGNET AND SOME OF ITS APPLICATIONS.*

THE practical solution of certain problems requires the production, at a distance, of certain mechanical effects, for which electricity is at once marked out as suitable.

But ordinary electro-magnets are sometimes unsuitable. Except in very short circuits, with very strong batteries, they have comparatively small force; besides, they act under very unfavourable conditions, for at the moment when they have to produce their greatest effect in order to give to their armature the initial movement, this is in its most distant position. Now the magnetic action, we know, diminishes with the distance, and that very quickly. Consequently the armature can only have a very limited course. To multiply the effects of these electro-magnets, they have been furnished with relays and local batteries, or mechanism more or less complex.

Professor Hughes has employed for his printing telegraph an arrangement by which may be obtained directly an action of considerable energy. This magnet does not directly develop a force, but it permits a force, held in reserve, stored up, to act at a given moment with all its intensity.

It is composed of a fixed horse-shoe magnet, the branches of which are prolonged by iron cylinders enclosed in bobbins. These cylindrical cores become the true poles of the magnet, and hold an armature in contact.

If we pass through the bobbins a current of the direction opposite to that which would produce a magnetism of the same species as that of the magnet, the latter is weakened; it then lets go the armature under the action of an antagonistic force (weight or spring), which may be utilised as motor.

One can see that this force has no other limit than that of the attractive force of the magnet which may counterbalance it, so as to retain the armature. The latter force may be very great, several hundred kilogrammes, with such magnets as can now be made, and the antagonistic force is easily multiplied by simple processes.

We may, then, produce at a distance and instantaneously, certain very considerable mechanical effects, provided that after each effect produced, the antagonistic force can be restored by some motor, and the armature returned to contact with the electro-magnet.

Thus, in apparatuses based on a use of the Hughes electro-magnet, three forces are brought into action.

(1). The force to be utilised, the action of which is prepared, and which is stored up by some motor.

(2). The attractive force of the magnet, which counterbalances this force.

(3). The electricity which ruptures the equilibrium of these two forces, and weakening the second, allows the first to produce its effects.

If the difference between the attraction of the magnet and the antagonistic force be suitably calculated, it will be sufficient if we develop in the cores of the bobbins a very weak contra-magnetism; and, indeed, the elements of the battery that are employed are arranged in tension, and their number depends only on the distance at which the action is to take place; in a word, on the length of the circuit.

The Hughes electro-magnet has this further advantage over ordinary electro-magnets, that it operates with passage of currents which one might call instantaneous; indeed, the point is not to attract an armature by the influence of a force which must persist during the time of attraction; the electricity, in the Hughes magnet, merely serves to interrupt for one instant a permanent action, and thus it acts like a pair of scissors with which one might cut a cord suspending a weight, which would then fall under the influence and according to the laws of gravity.

* Abstract of paper by M. Lartigue in the *Journal de Physique*.

To appreciate this instantaneity, it is sufficient to recall the prodigious numbers of letters printed per minute by the Hughes telegraph, notwithstanding the multiplicity of actions independent of electricity which concur in the impression of each of them.

Apart from the use of Hughes's magnet in telegraphy, there are other applications which may be made of it, and which we have had in use for some years. We will indicate some of these.

(1). *Opening and Closure of Stopcocks, Valves, &c.*—When the case is that of a gas or a liquid under weak pressure, the problem is very simple. It is sufficient to attach to the key for turning the plug of a cock, a counter weight with projecting armature, which a Hughes electro-magnet holds in unstable equilibrium, and which falls when a demagnetising current is sent, either automatically or at will. Where there is strong pressure, it is well, so as to avoid the use of too powerful magnets, to adopt the form of valves with counter-pressure piston.

(2). *Electro-automatic Whistle for Locomotives.*—One of the most important questions in the working of railways is that of signals. The signal apparatuses by which engine drivers are guided are movable pieces, discs or arms, which, in one position, indicate that the way is clear, and in the other that the train must be stopped; but if from any cause they may not have been noticed, all guarantee is gone.

It has often been attempted to confirm the sight signal by an acoustic signal, but without practical success. The employment of electricity with the Hughes electro-magnet has enabled us to attain the desired result by an apparatus which may be thus described.

A steam whistle opens or closes by action of a horizontal lever. Near the free end of this lever is jointed a vertical arm connecting it with the middle of a parallel lever below; thus the two levers move in correspondence. The free end of the lower one is held up by a Hughes' magnet, while the current is not passing, and thus the steam-whistle is kept closed; but if a current pass, the lever is released under action of a spring, and thus the whistle acts. The apparatus, enclosed in a metallic case, is fixed on the locomotive in front of the engine-driver.

The source of electricity is a battery placed near the sight signal on the railway; it is also utilised for sounding an alarm bell near the lever which produces the signal. When this lever is in the position for stopping, a communication is established between the pile, and a piece named the *fixed contact*, or, vulgarly, *crocodile*, placed longitudinally, at a suitable height, between the rails, at a certain distance in advance of the sight signal. This piece is a wooden beam fixed by iron feet on the sleepers, and having on its upper surface a metallic plate with which is connected the battery wire.

Under the engine, and connected by insulating wire with the electro-magnet, is a metallic brush, which, in passing, rubs against the *crocodile*.

When the signal indicates the line is clear, the pile being insulated from the contact-plate, no effect is produced; if, on the other hand, the signal is to stop, then, whatever the velocity of the engine, an instantaneous circuit is established, and the whistle sounds until the engine-driver raises the upper lever again, and closes the valve, thus, at the same time, returning the armature of the lower lever to the electro-magnet. This whistle has been used for more than two years on many locomotives on the Chemin de Fer du Nord.

It is also employed to give signals in workshops, mines, steamboats, and like cases, where it is desired to produce automatically a strong and continuous call. In slightly changed form, and connected with clockwork, it has been tried in lighthouses for producing at a distance, through a steam-trumpet, acoustic signals confirmative and supplementary to luminous signals.

(3). *Electric Pawl.*—We have utilised the properties of the Hughes electro-magnet in producing, either automatically or at will, engagements or disengagements, locking or unlocking, of brakes, winches, hoists, &c. A description was given last year of the mode of using it in manœuvring the stage decorations, &c., in the new Opera House in Paris.

(4). *Electro-Semaphores.*—This is an application of the magnet in connection with the *block system* on railways. Such semaphores are used on the line from Paris to Creil by Chantilly.

(5). *Urgent Alarm Bell* (*Sonnerie d'Urgence*).—This is for preventing the employment of a telegraph station when an application which it receives calls for a reply stopping all business. It consists of a Hughes electro-magnet, the bobbins of which are in the circuit of the wire which connects to earth all the receiving apparatuses (printer or bell) of a station. All the currents received in these apparatuses, then, will traverse the bobbins, but produce no effect if they are in a certain direction. But if one of the correspondents sends a current in the contrary direction, the magnet releases its armature, which then makes the circuit of a special alarm bell. The *employé* will thus be informed that an urgent message is addressed to him; the action of the ordinary receiving apparatus indicating, at the same time, whence the message comes.

These are a few of the possible applications of the Hughes electro-magnet; it is easy to conceive of others.

RAILWAY SIGNALS.

By J. DUTTON STEELE, C.E.

(Concluded from p. 30.)

Another subject that has received much attention in England in connection with the fixed signal system is the interlocking of signals and switches, by which the lever motion that turns the switch turns also the signal for trains moving past it, and at the same time locks the switches and signals at other places, the movement of which might interfere with the movement of the train under immediate guidance.

This, it will be seen, involves the employment of two mechanical principles which have not thus far received a great deal of attention in our country; the connection of the several switches and signals at a station by an extended system of connecting rods, compensating bars, and bell cranks, and the bringing together of the levers moving them to one or more stands or platforms arranged for the purpose. On the Great Northern Railway, upon one such platform or "locking frame," there are eighty levers moving and locking as many switches and signals, some of them more than a quarter of a mile away.

The extent to which the interlocking system has been carried does not seem to meet with universal approval among English engineers. One gentleman says he does not like the large accumulation of levers in one frame; another, that the number of levers in a box sometimes frightens him; a third mentions a conversation with a switch-man, in which the time required to pass a train through being referred to, as too great for busy days, replied, "On them days we pulls out all this gear." There is, however, no difference of opinion as to the value of interlocking switches and signals to a certain extent, and that is as true to-day in American as in English practice. As a general rule, our condition in that respect is the same as England's previous to the introduction of the interlocking system, when the Liverpool and Manchester Railway managers declared that "they had no system, but put good men in the places, and saw that they attended to their duty."

Although it may be that, in certain cases, interlocking and lever concentration has been carried to an undue extent in England, yet it is far from the intention of the members of the Committee to question its efficiency or importance; they foresee that it must come into extensive

use at our principal railway stations, and have been informed that, since their appointment, both the New York Central and Pennsylvania Railroad Companies have commenced its introduction at their New York termini. The devices there used are the "Farmer and Saxby," to which those desiring further information are respectfully referred.

This review of European practice shall be closed by a brief reference to the automatic systems, both mechanical and electrical, without attempting a detailed description of the arrangements which are in use, and which are accessible to those who desire information upon that subject.

The experience of a quarter of a century does not seem to have obtained for them general favour in England, though the Siemens's improved electric signals are being introduced upon the continental railways, and upon the principle "of the survival of the fittest" its friends claim for it a large future. One gentleman, speaking from much experience in electric signals, says, "Without the aid of a great staff of electricians to keep them going, he would not like to depend upon them;" another, that "They are only suited to thickly settled districts." It is scarcely necessary to say that all such arrangements require the most accurate mechanical details; and the objections to them that are found in English practice will exist to an increased extent in America, where extreme atmospheric disturbances are not uncommon.

Siemens's Magnetic Inductor, now being extensively used in Europe as a substitute for the Morse battery for electric communication between signal stations, is thus described in a circular:—"It consists of twelve permanent magnets, between which a cylindrical armature is mounted, and each complete turn of the armature produces two currents in opposite directions in a coil of insulated wire forming part of the cylindrical armature; one revolution of the handle causes the pinion to revolve thirteen times, and, consequently, twenty-six currents, alternatively positive and negative, are generated in the insulated wire coil by one revolution of the handle, and sent into the line wire. Its strength is said to excel a battery of one hundred elements; it acts more energetically, and is free from atmospheric influences. There are no expenses of cleaning and maintaining the batteries; it requires no complicated connections; the protecting case guards the instrument against damage; and, on the whole, it simplifies the service, and gives a greater guarantee of the exactness of all railway signals."

Conclusions.—Having briefly reviewed the signal service as it is employed in Europe and America, we would invite the attention of the Society to the conclusions arrived at.

It is not necessary to dwell upon the appliances for train and hand signals; the whistle, gong, flag, lamp, and torpedo are in universal use, and will continue to "talk at a distance" until some better modes, not yet known, are substituted for them.

Of station (fixed or block) and switch signals, there is an almost infinite variety—semaphores, vanes, targets, balls, &c.,—differing as much in their significance in different localities as there are shades of minds in their application.

In Europe the semaphore is rapidly taking the place of all other signals, and in America, the larger the roads and the business, the more uniform the character of the signals, and the fewer the rules for their observance.

It is quite possible to govern the movement of trains upon any road by one class of signals, which, as indicated by the use of the semaphore, seems to be the present European idea, but experience there does not point unequivocally to such singleness of practice. Switch signals have but two ideas to transmit—right and wrong; the block and road signals have three—danger, safety, and caution; whilst the station signals, being required to direct the movement of trains in various ways, should have a more copious significance.

Switch signals should be automatic; that is, the same lever motion that moves the switch should also change the signal. The English target, which has already been adopted upon several of our principal roads, seems to meet all the requirements of a good switch signal.

For block or fixed signals the vane seems to be the most suitable, and the best samples are upon the Philadelphia and Reading Railroad, where it has been the most extensively used. The office of block or road signals is to announce the condition as to safety by the exhibition of a red, white, or blue colour, and this can be done more quickly and certainly by turning a vane than by hoisting a ball or changing the arm of a semaphore; and the black board dividing the signals for moving trains in opposite directions facilitates the operation, and prevents confusion.

For grade crossings, the essential feature is that the same signal movement that opens one road shall block the other, and that neither road can be opened by signal without at the same time blocking the other, regardless of the character of the train approaching. Each road must be either open or blocked to all trains at the moment of crossing, and no other question should be presented to the signalman at the point of intersection but that of safety; all questions of priority should be otherwise disposed of. In this view of the case, we still find the ×-shaped vane, with two red and two white faces placed in one of the angles of intersection, the most simple and best crossing signal, either in its primitive form or modified by the double cylinders, as adopted at the crossing of the Philadelphia and Trenton Railroad.

Tunnel and drawbridge signals have a somewhat different duty to perform, but the only intelligence they have to transmit is that of danger or safety, and we still find the vane, with its red and white faces, the most certain and convenient device for such purposes.

At the regular stations more time can be allowed for the train-men to consider the meaning of signals, and the range of ideas to be communicated is from a simple notice to stop at a local point for passengers, up to the movement of the frequent trains upon the multifarious tracks of our extensive stations. For this purpose the semaphore seems to be the best adapted; three ideas are communicated by the three positions of a single arm, and the number of arms and the number of posts may be increased indefinitely.

The colour-signals seem to have become uniform all the world over, with some unimportant local variations which should be obliterated.

The audible signals have a general similarity, but are not uniform; and there has not been sufficient attention paid to a correspondence of whistle and gong notes.

In all cases the standing signal should be the signal of danger; and trains should not be allowed to proceed until the signal announcing the condition of the road ahead has been given. No signalman can sleep with the red against approaching trains without being speedily called to account for his omission of duty.

The progress of signalling through it several stages must be governed by the growth of the traffic it has to conduct safely over the rails. For roads of small traffic the hand and train signals will suffice; and a single-track road has not reached its ultimate capacity to accommodate traffic until fixed signals, connected by magnetic telegraph, and provided with sidings to pass fast and slow trains, have exhausted their powers of expanding that capacity. Double-track roads have not reached their ultimate capacity until the full block system, with suitable siding room, has been applied to them. It is not until the expansive powers of signalling have been exhausted that additional tracks need be laid, and it thus that this branch of railroad service becomes an important element of economy, and a means of avoiding large outlays of capital. It is frequently said that railroad companies cannot afford to adopt a general signal system: is it not true that no road of considerable business can afford to do without such a system? The value of machinery alone in all railroad trains is from 20,000 dols. to 50,000 dols., independent of the freight they hold in transit, and a signal system is, to a large extent,

the insurance upon this species of property. From the report of a railroad company, giving a statistical statement of the accidents upon the road and the causes of the same, it appears that in a period of fifteen years, 1700 accidents occurred, in which, besides the injuries to the locomotives, 4770 cars were demolished. Of these, 2055 may be referred to the signal service, 1658 to defects in the road and rolling stock, 736 to carelessness of *employés*, and 321 to causes unknown. The death list upon the same road for the same period numbers 443.

The efficiency of signals in preventing accidents cannot be too forcibly impressed upon the railway interests at large. The block system is intended to prevent the possibility of collisions, and it is difficult to see how a collision can take place when that system is in use under intelligent direction.

Drawbridges guarded at the draw by a signal, which can only be moved automatically, and repeated a suitable distance on either side of the bridge, must be an absolute preventive of accidents; it is impossible to conceive of an accident at points so guarded unless the engineer is either blind or demented.

Railway grade crossings will be free from accidents if guarded at the intersection by signals which block one road when they open the other, and which are repeated when necessary at suitable distances on either side. No sane engineer will run past a red light in full view into an obstructed crossing.

We have laws requiring trains to come to a full stop before passing such points, which is well; but well devised signals are better, on the principle that an engineer in a hurry will be more likely to take risks by breaking the laws of the land than by breaking his own neck. We hear much of the carelessness of engineers as the cause of accidents, but, as a class, they have as high an appreciation of their lives, and of the risks of their calling as other men, and will not be found running into known danger. In a majority of cases, the want of care will be found more with those who have charge of the roads and running arrangements, and they should take full share of the responsibility.

Tunnels cannot be safely worked except by the full block system. Hoosac, with her five miles of length, cannot be safely worked on any other principle, although such an amount of business may be conceived as would make a block station desirable inside of tunnels so long as this.

The Committee is without necessary information to treat intelligently what may be termed the railway vocabulary of the semaphore, but American ingenuity will find no difficulty in supplying the deficiency. This report is closed by repeating the recommendations of the Institution of Civil Engineers, that uniformity should be obtained:—

1. In signals of danger, caution, stop, go-ahead, and go back.
2. In the character of the fixed signals used upon our several roads, for distinct purposes, such as switch, block, and station, and
3. That the signals should be as few and simple as possible.

DISTRIBUTION OF MAGNETISM IN BUNDLES OF VERY THIN PLATES OF INFINITE LENGTH.

By JULES JAMIN.

In my previous papers* I demonstrated that in a thin plate of infinite length the mean magnetic intensity y, at a distance x from the extremity, is represented by—

$$y = Ak^{-x},$$

A being a constant for the same steel, independent of its temper or anneal; k, on the contrary, decreasing with increase of anneal. I now propose to gather up a bundle or group of such plates, and consider the case, as a whole, in which the bundle may be accounted as infinite in length.

In former papers I showed how a saturated magnet is a bundle of magnetic elementary filets confined in the middle section as by a belt, and expanding outwards towards the extremities. The number of these depends only on the mean section, provided that the polar surfaces admit of its expansion. If the thickness of a plate is very small, equal at most to 1 millimetre, it may be considered uniformly magnetised throughout its entire mass; and the total magnetism M that it contains is equal to the product of its section $b\,c$ by a constant factor m, thus—

$$M = m\,b\,c \quad . \quad . \quad . \quad . \quad . \quad (1)$$

whence it follows that M ought to be—(1) independent of its length when once it exceeds a given limit; (2) proportional to its thickness c; (3) proportional to its width b. These three statements may be easily proved by Van Rees's method of induction for determining the quantity M. It consists in dividing M by $b\,c$, and successively varying the length, width, and thickness. *From these operations it will be found that* $\frac{M}{b\,c}$ *begins to lessen when the length is reduced to* 136 *millimetres.*

As regards the influence of thickness and width, it can, in the same manner, be shown that M is proportional to c and b.

This relation $\left(\frac{M}{b\,c}\right)$ demonstrates that if we superpose several identical plates their magnetisms are cumulative; they act as one whole plate whose thickness is equal to the sum of the several thin plates. The following table proves this:—

	Metres.
Length of plates	$0{\cdot}240 = l$
Width ,, ...	$0{\cdot}040 = b$.

Number of Plates.		m.m.	m.m.	m.m.	m.m.	m.m.	m.m.
Σc	..	2·25	16·00	12·70	11·00	0·44	0·76
$\Sigma b c$	..	90·00	64·00	50·80	44·00	17·60	30·40
M ..	..	49·20	32·50	25·50	23·00	10·10	16·10
$\frac{M}{\Sigma b c}$	..	0·55	0·50	0·51	0·52	0·57	0·53

The law is applicable to the case in which the plates, though of similar form, are of different steel. It then assumes the algebraic form of—

$$M = b\,(m\,c + m'\,c' + m''\,c'').$$

In like manner it lends itself to the case in which the plates are superposed in any direction whatever (presenting at each extremity north and south poles mixed), when the equation becomes—

$$M = b\,(\Sigma\,m\,c - \Sigma\,m'\,c').$$

I made some experiments with five plates of equal length and width: l = 500 m.m.; b = 38 m.m., thickness being approximately = 0·4 m.m. Examined separately they gave the following values for M:—9·7, 8·4, 8·5, 10·2, 7·2. They were then packed up with all the poles in the same direction; afterwards the last plate was turned round; and finally the two last. The results were for the value of M:—

	Observed.	Calculated.
Plates all in same direction ..	44·0	43·9
The last turned round	28·3	29·0
The two last turned round ..	9·1	9·0

I will add, lastly, that on separating the bars they were found in the same state as before their superposition; and I have never observed, like Coulomb, that the outer plates of a compound magnet were more charged than those in the centre.

* Electrical News, pp. 16 and 27.

It is thus shown that by laying plates one on the other, in any number and in any direction, the group contains the algebraic sum of their magnetisms. This is, however, only true if the bundle is long enough to be considered as infinite. Let us, therefore, now enquire into the law regulating the distribution of the total magnetism in such a group of plates.

For this purpose I made use of 50 plates, as alike as possible (obtained from long strips of the same steel, manufactured at the same time), whose thicknesses c were equal to 0·040 m.m., the width b being equal to 40 m.m. The lengths were equal to 1 metre, which was enough for one or two plates, but when the bundle exceeded ten or fifteen plates the two magnetic inverse curves began to reunite. On such occasions, to that end of the bundles not under observation, were added long iron or steel armatures, which produced the same effect as if the length of the bundle were increased. Groups of 1, 2, to 50 plates were thus studied, by the method of contact-ordeal, with the following results :—1. That for any number of plates, n, the relation of the mean intensities in two sections situated at distances x and $x+1$ is constant, and equal to k_{n1}, thus proving that the intensities are always represented by the formula—

$$y_n = A_n k_n{}^{-x} \quad . \quad . \quad . \quad . \quad (2)$$

2. That the ordinate A_n at the extremity of the bundle increases with n; and that the curve of the intensities rises; and, lastly, that k_n diminishes,—in other words, the curve lengthens more and more.

Nothing now remains but to find out the law of the values of A_n and k_n. To do this we will find a conditional equation by calculating from formula (2) the total magnetism, and equalising it to that which is given by formula (1). Now, upon a strip of steel (of width equal to the unit) parallel to the magnet's axis, the magnetic sum will be found by integrating $y\,dx$ from zero to infinity; and M will be equal to that integral multiplied by the perimeter $2(b+c)$, *i.e.*—

$$M = 2(b+c)\int_0^\infty y_n\,dx = \frac{2\,A_n\,(b+c}{l.k_n},$$

a quantity which is equal to the sum of the magnetic filets in the middle section $b\,c$ or $m\,b\,c$. Thus—

$$m\,b\,c = 2A_n\,\frac{b+c}{l.k_n},$$

whence—

$$\frac{m}{2} = \frac{A_n}{l.k_n}\cdot\frac{c+b}{b\,c}.$$

In the case where the thickness c is equal to unity, A_n and k_n become equal to the constants A and k, determined before*: hence—

$$\frac{m}{2} = \frac{A}{l.k}\cdot\frac{1+b}{b};$$

rom which—

$$\frac{A_n}{\log. k_n}\cdot\frac{c+b}{c+b\,c} = \frac{A}{\log. k} \quad . \quad . \quad . \quad (3)$$

The second member of this last equation being constant, the first will be equally so, whatever n may be: this, indeed, is evidenced by the third column of the following table :—

This constancy in my experiments sensibly contradicted itself after thirty plates were added, and was, owing to a host of causes, conducive to error (which shall be mentioned hereafter), as well as to the last twenty plates being rather thinner than the others.

To fully determine A_n and k_n another equation is needed. It will be discovered on remarking that A_n and log. k_n, varying inversely their product is constant. Let us then place—

$$A_n \log. k_n = A \log. k \quad . \quad . \quad . \quad (4)$$

and equations (3) and (4) will give us—

$$A_n\sqrt{\frac{c+b}{c+b\,c}} = A;$$

$$\log. k_n\sqrt{\frac{c+b\,c}{c+b}} = \log. k_n.$$

The second terms of the above being constant, it follows the first will be so likewise, and so the table shows in the fifth and sixth columns. Whence we find—

$$A_n = A\sqrt{\frac{c+b\,c}{b+c}};$$

$$k_n = k\sqrt{\frac{c+b}{c+b\,c}}.$$

and the final formula of the magnetic intensities on a group of n plates thus resolves itself into—

$$y_n = A\sqrt{\frac{c+b\,c}{c+b}}\,k^{-x\sqrt{\frac{c+b}{c+b\,c}}}$$

—a formula which becomes $A\,k^{-x}$ when the thickness c = unity. The determination of the constants A and k (as was done in my last paper) enables us thus to calculate all the conditions of a group of thin plates of the same steel when it is long enough to be considered as infinite.

I close by mentioning that to efficiently study a group of a large number of plates they must be well polished, very flexible, and very strongly pressed against each other. When this is not done, a part of the total magnetism—instead of reaching the exterior—remains between the plates, and that portion increases with the separating spaces. On interposing pasteboard the preceding laws do not hold, but they are approached more and more on more closely binding the bundle together. It is noticed that A_n and k_n both increase up to the limit expressed by the formulæ as above; and, as the absolute contact of the plates in all their surfaces is impossible, divergencies exist between theory and experiment which augment with the number of layers, and which, when the grouping exceeds thirty plates, is apparent from the above table.

Number of Plates.	A_n	k_n	$\frac{A_n}{\log. k_n}\ \frac{c+b}{c+b\,c}$	$A_n \log. k_n$	$A_n\sqrt{\frac{c+b}{c+b\,c}} = A$	$k_n\sqrt{\frac{c+c\,b}{c+b}} = k$
1	1·99	1·295	43·78	0·213	3·13	1·178
2	2·74	1·184	46·70	0·200	3·06	1·163
3	3·90	1·164	39·32	0·252	3·57	1·180
4	4·28	1·122	54·28	0·214	3·41	1·155
6	5·10	1·102	52·02	0·215	3·34	1·160
8	5·62	1·078	56·66	0·184	3·22	1·140
10	6·25	1·082	49·04	0·214	3·24	1·164
14	6·80	1·065	49·26	0·186	3·02	1·152
20	8·21	1·062	45·98	0·215	3·15	1·170
30	8·60	1·053	40·39	0·193	2·79	1·178
40	9·46	1·033	56·95	0·134	2·76	1·116
50	10·00	1·028	61·04	0·120	3·04	1·086

* For values of A and k see page 28.

TESTS OF A MAGNETO-ELECTRIC MACHINE.*

By Prof. E. C. PICKERING and D. P. STRANGE,
Massachusetts Institute of Technology.

(Concluded from page 14).

Next, to determine the relation between the four variables—speed of revolution, resistance in circuit, current, and electro-motive force. An attempt was also made to measure the work required to run the machine, and the coefficient of efficiency; but, from lack of proper dynamometric facilities, the attempt was necessarily abandoned after the first series of experiments.

The results of these experiments are given in the following tables in which R is the resistance of the circuit, expressed in ohms; S is the speed, or number of revolutions of the armature per minute; C is the current in vebers per second; E is the electromotive force in volts; E_1 is the computed electromotive force in volts, which would have been obtained with a speed of 1000 revolutions per minute; W is the work expended, in foot-pounds, including friction; W.C is the work the current is capable of doing, in foot-pounds; and C.E is the coefficient of efficiency of the machine, obtained by subtracting the work required to drive the machine on an open circuit from the actual work W, and dividing the computed work W.C by the remainder.

Table II.

R.	S.	C.	E.	E_1.	W.C.	W.	C.E.
264·600	750	0·023	6·10	8·13	0·104	306	—
227·400	—	0·027	6·09	8·11	0·121	306	—
190·300	—	0·032	6·08	8·11	0·143	—	—
153·200	—	0·040	6·08	8·11	0·178	—	—
116·000	—	0·052	6·10	8·13	0·238	—	—
78·900	—	0·078	6·16	8·22	0·335	—	—
52·600	—	0·131	6·88	9·04	0·664	—	—
41·700	760	0·159	6·67	8·76	0·788	—	—
41·500	—	0·162	6·72	9·02	0·816	309	—
27·600	745	0·336	9·28	12·45	2·340	328	—
21·800	745	0·587	12·79	16·90	5·640	—	—
15·440	740	1·420	21·14	28·50	22·500	550	0·096
11·440	730	2·200	25·16	34·50	41·500	697	0·105
7·500	725	4·170	31·29	43·10	97·900	955	0·146
5·150	725	5·290	27·24	37·50	108·100	—	—
4·440	720	6·320	27·43	38·10	124·900	1274	0·122
4·440	580	6·960	30·91	53·30	161·400	984	0·228
2·970	425	11·260	33·39	78·50	282·100	952	0·362
2·780	590	8·620	23·96	40·60	154·900	1403	0·133
2·300	—	9·710	22·32	39·80	162·400	—	—
1·956	530	10·050	19·66	37·10	148·200	—	—
1·786	310	11·580	20·68	66·70	179·600	735	0·284
1·656	520	11·300	18·68	35·90	158·300	—	—

Table III.

R.	S.	C.	E.	E_1.
333·60	—	0·020	6·62	6·96
296·50	950	0·022	6·58	6·91
259·30	—	0·026	6·64	7·00
222·50	—	0·030	6·62	7·02
185·70	940	0·036	6·67	7·09
148·80	—	0·045	6·73	7·13
111·60	945	0·061	6·85	7·25
74·50	—	0·092	6·87	7·29
37·95	940	0·206	7·80	8·29
30·48	925	0·476	14·51	15·70
26·57	925	0·594	15·78	17·00
21·65	—	0·899	19·47	21·10
16·70	920	1·960	32·73	35·60
13·76	—	2·720	37·42	41·10
11·77	905	3·410	40·11	44·30
9·81	900	4·390	43·07	47·90
8·94	890	5·060	45 25	50·90
7·80	870	5·860	45·70	52·60
6·92	840	4·900	33·90	40·40
5·91	670	6·170	22·30	33·30
3·93	550	6·760	26·60	48·40
2·95	510	9·400	27·70	54·40

* A Paper read before the American Academy of Arts and Sciences May 11, 1875. Communicated by the Authors.

Table IV.

R.	S.	C.	E.	E_1.
333·60	1170	0·025	8·31	7·11
296·50	—	0·028	8·31	7·11
259·30	—	0·032	8·33	7·14
222·50	—	0·037	8·34	7·19
185·70	1160	0·045	8·36	7·21
148·80	1140	0·057	8·41	7·38
111·60	1120	0·076	8·44	7·54
74·50	1110	0·115	8·54	7·70
37·95	1100	0·230	8·73	7·98
74·50	1140	0·127	9·44	8·29
37·95	1140	0·252	9·58	8·61

Table V.

R.	S.	C.	E.	E_1.
333·60	1330	0·030	9·93	7·47
296·50	—	0·033	9·86	7·42
259·30	1320	0·038	9·80	7·42
222·50	1320	0·044	9·88	7·49
185·70	1325	0·053	9·86	7·46
148·80	1325	0·066	9·83	7·45
111·60	1320	0·090	10·05	7·62
74·50	—	0·137	10·20	7·73
37·95	1325	0·293	11·14	8·56
21·20	1380	1·370	29·01	20·86
16·30	1365	1·990	32·26	23·20
12·30	1350	3·150	38·70	28·70
8·60	1300	4·980	42·80	32·90
7·60	1280	5·780	43·90	34·30
6·60	1230	6·960	46·00	37·40
5·60	960	7·170	40·20	41·80
4·80	880	7·750	36·50	41·40
4·10	850	8·110	33·20	39·10

Table VI.

R.	S.	C.	E.	E_1.
333·60	1620	0·036	12·01	7·41
296·50	1615	0·040	11·92	7·38
259·30	—	0·047	12·27	7·56
222·50	—	0·054	12·02	7·42
185·70	1630	0·065	12·05	7·39
148·80	—	0·082	12·19	7·48
111·60	1625	0·109	12·22	7·57
74·50	—	0·165	12·29	7·61
37·95	1625	0·332	12·60	7·80
26·20	1675	1·310	34·31	20·50
21·20	1675	1·820	38·59	23·10
16·30	1675	2·450	40·01	24·00
12·30	1635	3·420	47·06	28·80
8·60	1260	4·820	41·47	54·40

Table VII.

R.	S.	C.	E.	E_1.
333·6	2010	0·041	13·7	6·81
296·5	—	0·046	13·6	6·78
259·3	—	0·053	13·7	6·93
222·5	—	0·063	13·9	6·81
185·7	2010	0·074	13·7	6·77
148·8	—	0·092	13·6	6·62
111·6	2015	0·120	13·4	6·65
74·5	—	0·174	13·0	6·39
37·9	2015	0·317	12·0	5·96

From an examination of these tables several important conclusions may be drawn. For large resistances, over 38 ohms for instance, the electromotive force is nearly proportional to the speed, and is given by the equation $E = 0·007\ S$. The advantage of placing the magnet in the main circuit is here in a great measure lost, since the large outside resistance so far reduces the current that its effect on the magnet is slight. The constant 0·007 affords a good means of comparing various machines of this form, since its magnitude depends directly on the arrangement of the magnet and armature. For resistances less than 38 ohms, the electro-motive force rapidly increases by an amount which is approximately given by the

formula, $E = S\ (0{\cdot}042 - 0{\cdot}0009\ R)$, from which we see that the electro-motive force continually increases as we diminish the resistance, and, if the resistance could be reduced to zero, would attain the value $E = 0{\cdot}042\ S$.

The column E_1 is computed by assuming the electromotive force proportional to the velocity. This column can be used more conveniently than that marked E, since with small resistances the power required was so great as to make the belts slip, and greatly diminish the speed.

In Table II. some measurements of the power are given, as also the ratio of the theoretical power to that actually employed. The latter was measured by the dynamometer, the former computed by the very convenient theoretical formula, $W = \frac{3}{4}CE$. From the results, it will be seen that, for large resistances, the power employed, beyond that required to drive the machine, is insignificant, but rapidly increases as the resistance diminishes; the efficiency also at the same time increasing and attaining its greatest value with the smallest resistances. Of course, the absolute efficiency, or ratio of electricity generated to power expended, would be still less than this, being very small for large resistances, and attaining a maximum of about 30 per cent. When we consider, however, how large an amount of work is consumed by even a small amount of heat, the coefficient in the above cases must be regarded as large.

A series of experiments was next made to determine the strength of the current generated in different positions of the armature. The apparatus was constructed by Mr. S. J. Mixter, and consisted of a wooden wheel attached to the armature, and revolving with it. On this rested a brass wire; and a strip of copper was inserted in the wheel, so that it established contact between the axle and the wire, through an angle of about 10°. The latter was supported by a second larger wooden wheel, which could be turned and held in any desired position by inserting a pin in one of a series of holes in its circumference, at intervals of 10°. The experiment was performed by connecting the brass wire and axis of the machine with the galvanometer, so that during each revolution of the armature the current would be for an instant diverted through the galvanometer, these currents following each other so rapidly when the machine was running as to produce a sensibly constant deflection. The larger wheel was then turned 10°, and the observation repeated. The 0° and 180° of this wheel correspond to the points where the circuit is reversed by the commutator.

TABLE VIII.

P.	C.	C.
0	0·0498	0·1015
10	0·0503	0·0912
20	0·0378	0·0786
30	0·0338	0·0693
40	0·0284	0·0620
50	0·0257	0·0514
60	0·0211	0·0399
70	0·0159	0·0392
80	0·0136	0·0385
90	0·0130	0·0392
100	0·0141	0·0446
110	0·0152	0·0588
120	0·0188	0·1000
130	0·0343	0·1329
140	0·0638	0·1406
150	0·0715	0·1367
160	0·0678	0·1260
170	0·0629	0·1162
180	0·0498	0·1015

Table VIII. gives the result of two series of experiments of this kind, the wheel being turned through 360°, and the mean of the two readings at intervals of 180° taken. Column 1 gives the angle through which the wheel has been moved, and column 2 the current, the main circuit having a resistance of 16·7 ohms, and the galvanometer circuit a resistance of 1·3 ohms. Column 3, in like manner, gives the current when the resistance of the main circuit is reduced to 10 ohms. An examination of this table shows that the current at no point becomes zero, but varies from a maximum at about 145° to a minimum at 90°. If the distance of the poles of the magnet was large compared with the motion of the armature, the current would vary as the sine of the angle, supposing that there was no induction or other disturbing cause. Accordingly the current would become zero at two points midway between its two maxima, and this would be the point where the commutator should be placed. In that case no spark would be seen at the commutator, since the circuit would be broken only when the current was zero. In practice it was found that there was no portion of the commutator where the spark could be entirely avoided when the resistance was small, evidently owing to the fact shown by these observations, that the current at no point is zero. Moreover, on constructing the curves with co-ordinates equal to the angles and currents, it will be seen that the inclination is much greater before than after the maximum; so that the latter, as stated above, is distant only about 55° from the minimum, instead of 90°. The cause of the deviation from the curves of sines is probably the current induced by the magnet, which adds or subtracts its effect according as the current is increasing or diminishing.

In trying experiments upon the light produced by the current several difficulties were encountered. One of the most serious of these was from the slipping of the driving belts, when the machine was running at high rates of speed and the circuit was made through so small a resistance as the regulator and light. From this cause we were unable to obtain a steady speed of more than 1300 revolutions per minute, which was not sufficient to give the best results. A further difficulty was experienced from the great difference in power required to run the machine when the current was passing, and when the carbons became so far separated that the current was unable to pass. A change of probably 4 or 5 horse-power was thus almost instantly made, whenever the current was made or broken, and the consequent shock upon the machinery was very great. It also appeared that the form of regulator used (Duboscq's) was not capable of controlling the current so that the light should be steady. When the carbons were brought in contact the current was so great that the magnet acted strongly, starting the reversing clockwork and separating them ¼ an inch or more. This broke the circuit, and the machine began to revolve very rapidly; soon the carbons were brought together, throwing a great strain on the engine, and thus they oscillated, producing a very bright light for an instant and then extinguishing it. Better results would probably be attained without the reversing arrangement, by a change in the magnet of the regulator, or by increasing the electromotive force of the current. Some results were, however, obtained by a very careful adjustment of the spring holding the armature. With a velocity of 1130 revolutions a tolerably constant light was obtained. Current, 3·65 vebers. Resistance in circuit, about 10 ohms. Resistance of light, 3·3 ohms. With a speed of 1325 total resistance 9 ohms, and current 5·71 vebers, a light varying from 600 to 900 candle-powers was obtained. With a speed of 1280, resistance 7 ohms, and current 5·20 vebers, the light varied from 650 to 900 candle-powers. Doubtless a much greater light could be obtained with a different regulator and means of obtaining a high speed.

The effects of the current were very fine, and have been frequently described in connection with the Wilde, Gramme, and other machines. Thick wires were melted, heavy weights sustained in the air, in the interior of large coils, and excellent diamagnetic effects shown. The induced current on breaking the circuit was very severe when taken through the body, and the spark very long and bright.

The advantages of this machine are its simplicity, compactness, and small weight, compared with other machines of equal power; and little or no trouble was experienced from heating with the currents here employed.

NOTES.

It has been announced that Mr. Scudamore has accepted an appointment under the Turkish Government, and that he will shortly proceed to Constantinople to organise the Turkish International Ports in accordance with the terms of the Berne Convention. This announcement will be received with regret by all who know how much Mr. Scudamore has contributed to the present success of the State Telegraphs in this country. We can pay no better tribute to his administrative skill than by quoting the following particulars of the progress of the telegraph from the *Daily Telegraph* of the 26th instant:—"It is little more than five years since the Government acquired the telegraphic system of the country; but in that short time some marvellous results have been achieved. The total number of offices open to the public, which at the time of the transfer was about 2000, is now little short of 5600, of which upwards of 450 are in London alone. The number of messages forwarded annually has increased from six millions to twenty millions; and the average charge for an inland message has been reduced from 2s. 2d. to 1s. 2d. Of words transmitted on behalf of the press upwards of 220,000,000 are delivered annually, as compared with something like 2,000,000 in the days of the telegraph companies. Those companies possessed about 5600 miles of line and 49,000 miles of wire. The Post-Office possesses 24,000 miles of line and 108,000 miles of wire. But the number of instruments has increased in a still greater proportion—all of the companies together possessing fewer than 1900 instruments, as against upwards of 11,600 worked by the Post-Office. The Wheatstone apparatus, hardly known or understood half-a-dozen years ago, and so essential for the carrying on of the news service of the country, has been introduced by the Post-Office to the extent of nearly 150 sets; while the "duplex" or double working system is in general operation throughout the country, and is in use in the central telegraph stations in London on no fewer than 75 separate lines. The pneumatic tubes of the old system were about 20 in number, and measured some 3 miles in length; those of the Post-Office are 55 in number, and measure upwards of 23 miles. Besides extending and maintaining its own system, the Post-Office has lent help in several directions towards perfecting the system of military telegraphs. It has thrown open a portion of its service to a detachment of the Royal Engineers, who have been trained, at its expense, to erect and maintain telegraph lines, although it is understood that these officers are in no sense necessary to the telegraph service of the country, which could be equally well carried on minus the expense which the Post-Office is now put to in order to make room for them." Thus, thanks to the untiring energy of Mr. Scudamore, this country possesses an unrivalled telegraphic system. Mr. Scudamore has, however, had great difficulties to contend with. His strength has been severely taxed, and now, after having been in the service of the Government for thirty-five years, the state of his health renders it necessary for him to retire. Few men deserve a larger share of the nation's gratitude.

The new convention and working regulations of the International Telegraph Conference will come into operation on the 1st of January next. The Convention, which is an International Treaty, and practically unalterable between two Conferences, has been reduced from about 60 to 20 articles, and now contains only the bare principles upon which the contracting Governments agree that their lines should be established and their messages interchanged. The working regulations, which can be modified at any time by common consent, have been augmented by the 40 articles from the Convention. The following are the principal clauses of the new Convention:—The terminal charge of Germany for correspondence with France and Russia will be 3 fr.; the terminal charge of Austria for correspondence with Great Britain will be 2 fr. 50 c.; the other terminal charges for European countries remain unchanged. A new rate of 7 fr. 50 c. is agreed upon for Spain by the Direct Spanish Cable Company, and the transit rate by the cable between Barcelona and Marseilles is fixed at 4 fr. A word-rate has been agreed to for all extra-European countries, and uniform terminal rates are fixed for telegrams between Europe and India, viz.—For stations west of Chittagong *via* Turkey, 5 fr. per word; to the east of Chittagong, 5 fr. 25 c.; and Madras, 3 fr. 75 c.: *via* Russia, the rates are respectively 5 fr. 50 c., 5 fr. 75 c., and 4 fr. per word. Between such countries as choose to admit it, provision has been made for a "telegraph card" of ten words at three-fifths of the charge for an ordinary 20-word message, and under a similar restriction urgent messages at treble charge will be transmitted, and will have precedence of other private messages between the countries that admit them. By the payment of £1 per year, the names and complete addresses of two correspondents can be inscribed in the books of two distant telegraph departments, and be thenceforth represented by a single word, which alone will be telegraphed and charged for. The Conference is the fourth of a regular triennial series, the first of which was held at Paris in May, 1865; the second at Vienna, in 1868; and the third at Rome, in 1872. As we stated in a previous number, the next Conference will be held in London in 1878.

In reply to Mr. Monk, the Chancellor of the Exchequer stated in the House of Commons on Monday evening last that the £77,000 awarded to the Great Eastern Railway Company has been taken from the capital authorised to be raised by loan under the Telegraphs Act a few years ago. The powers of the Act are not exhausted, and they are more than sufficient to meet this claim.

Mr. G. Von Chauvin, the manager of the Direct United States Cable Company, writing to the *Times* in reply to complaints about the silence maintained by the officials as to the position of the cable, says that all persons whose names appear on the register of shareholders, and who have made inquiries either personally or by letter at the offices of the company, have received the information that the laying of the cable has been completed, that messages

were transmitted over it at a high rate of speed between New York and London, but that a small part of the cable had been injured, probably by the ice, during the laying of the last portion of the deep sea cable, and that the contractors were now cutting out and replacing the injured part.

The reports of the Italian Telegraph Service show that its development has very largely increased since 1861, when the present constitution of the empire was established. The following extracted statistical table of comparison will briefly show the increase:—

	1861.	1873.
Length of lines	4971 miles	13,670 miles
Length of wires	8078 ,,	43,497 ,,
Number of offices.. ..	225	1625
Number of instruments	400	2800
Government telegrams per annum	180,000	300,000
Private telegrams per annum	600,000	5,040,000

The total number of messages forwarded from Postal Telegraph Stations in the United Kingdom during the week ended the 24th July, 1875, was 446,532; during the corresponding week of 1874 410,351; showing an increase in the week of 1875 on that of 1874, of 36,181.

CORRESPONDENCE.

ACTION OF THE GALVANIC CURRENT ON THE ORGANS OF SENSATION.

To the Editor of the Electrical News.

Sir,—It will give me pleasure to read Dr. T. L. Phipson's paper, when I can obtain the *Comptes Rendus*.

As, however, the independence of the galvanic taste and chemical action was not the "conclusion" drawn in my paper, but rather the minor premise, it is difficult to see how it can have been "anticipated."

I am glad to have Dr. Phipson's testimony to the fact. —I am, &c.,

W. H. Stone.

14, Dean's Yard, Westminster, S.W.,
July 19, 1875.

ELECTRICAL SCIENCE IN FOREIGN JOURNALS.

(This column is devoted to a list of Electrical Memoirs published in Foreign Journals. Those of importance will be either translated in full or given in abstract.)

Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences. Vol. lxxxi., No. 3, July 19, 1875.

Reply to an Observation by M. Jamin in his Paper "On the Distribution of Magnetism in a Thin Plate of Great Length."—J. M. Gaugain.—M. Jamin said, in his paper of 28th of June last, that for some of his experiments he made choice of the method proposed in 1849 by Van Rees, and added (see Electrical News, vol. i., p. 28), "M. Gaugain has adopted this plan without modification." I wish to remark that I did not adopt Van Rees's method, for I re-invented it. When I undertook my researches upon Gramme's machine, I had no knowledge of Van Rees's labours; they are not mentioned in any French work, and I do not think I am far wrong in saying that M. Blondlot was the first to bring them into notice in this country. From him I am led to understand that the various methods I used had been employed for a long time, with more or less important modifications, by divers foreign physicists —Messrs. Lenz, Jacobi, Van Rees, and Rethlauf. I do not, therefore, claim priority. The method I employed to determine the curve of the magnetic intensities is described in my memoir on Gramme's machine,* and consists in marking the bar into equal parts—1 centimetre, for instance. I then moved an annular conductor from one extremity of the bar to the other, moving it only over one of the marked portions at a time, and noting the reading corresponding to each space so traversed. The curve was drawn by taking the measured bar-lengths for the abscissæ, and the corresponding readings for the ordinates. Now, undoubtedly, it is not evident that the intensity measured by this plan is proportional to the ordinary magnetic strength as measured by Coulomb's oscillating method; but I have experimentally proved that this proportionality does exist so long as we leave on one side the parts of the bar bordering on the extremities. As to the relation, that I have admitted, between the curve of the intensities and the curve of the demagnetisations, it evidently results from the mode of constructing the two curves. If Van Rees and myself have been led to use the same experimental process, we have been guided by different theories without interpreting the results in the same manner. With Van Rees, the induction current represents what he calls the *true* magnetism, *i.e.*, the *sum of the magnetic moments* belonging to the part of the bar upon which his helix is placed. With me, the induction current is that of *demagnetisation*, *i.e.*, the current which would be obtained in the given position of the helix if the magnetism of the bar were destroyed. According to Ampère's views, which I have adopted, this current gives the measure of the *solenoidal* current. In other words, if we imagine a solenoid of variable strengths, which possesses all the properties of the bar, the current of demagnetisation corresponding to a given point of the bar represents the strength of the current which courses the corresponding portion of the equivalent solenoid.

Poggendorff's Annalen der Physik und der Chimie, No. 6, 1875.

Time of Expiration of the Polarisation Current.—Prof. J. Bernstein.—Suppose a constant current sent through a decomposition cell, and the electromotive force, at a given moment, to disappear, it is required to find the rate at which the polarisation current diminishes in strength from that point. The author describes a number of experiments bearing on this. It is shown, *inter alia*, that the curve of the polarisation current is only in the first moments an approximately logarithmic one; in course of time it departs more and more therefrom, while it sinks more slowly to the line of abscissæ. This is explained partly by the behaviour of the gas layers deposited on the electrodes, smaller quantities of gas adhering more tenaciously to the metallic surface. The mode of absorption of hydrogen by many metals, and the change of surface of the hydrogen electrode, also influence the phenomenon. From another series of experiments, it was proved that the electromotive force of polarisation in a closed circuit, resistance and surface of electrodes remaining the same sinks the more slowly the greater its initial value; with increase of this, the velocity of disappearance, up to the maximum of polarisation, approximates to a minimum, and with decrease it approximates to a maximum.

Objections raised against Weber's Law.—M. Naumann.—Weber's view is that an electric current consists of the motion of particles of two kinds of electricity passing

* *Annales de Chimie et de Physique*, 4th series, vol. xxviii., No. 25 p. 339.

through the wire in opposite directions, and that these particles, when they are in relative motion, exert on other such particles forces different from those which they would exert in the condition of relative rest. The objections M. Naumann examines are, one by Tait and Thomson, viz., that Weber's law contradicts the law of conservation of energy; and two by Helmholtz which cannot here be adequately stated.

Spectral Analytic Researches.—M. Bunsen.—The author describes a battery and spark arrangement, with which the spark spectrum may be obtained with the same ease as flame spectra; also (in the second part, yet to appear) methods by which the substances, whose spectra are to be accurately determined, may be prepared free from all impurities.

Demonstration of Alternations of Electricity through Flame.—M. Fuchs.—The free end of an earth-connected secondary spiral is connected with the gold leaf of an electrometer; then, on sending the primary current in two directions, and interrupting, there occur four particular deflections of the leaf, equal in amount. The wire connecting the secondary spiral with the electrometer is next broken, and the two ends, furnished with electrodes, are placed in an earth-connected flame. There is now a marked difference in the deflections obtained; these the author investigates.

Contributions to the Theory of Laying and Testing of Submarine Telegraph Lines.—Werner Siemens. —Reserved for separate note.

Researches on the Magnetism of Steel Bars.—Dr. Fromme.—Among other results, the author states that the magnetisation-function, *k*, for forces which leave no remanent magnetism, decreases with increasing magnetising force, or so that the magnetic moment increases more slowly than the magnetising force. The function, *k*, has at first, with differently-elongated ellipsoids, very different values; greater, the less the excentricity. With increasing force, these divergent values approximate to a smaller limiting value, which is sooner reached the harder the steel used. Again, for every remanent moment of a steel bar, there exist, from zero on, a series of forces towards which the steel bar has the properties of soft iron. In general, the rule holds that the saturation with remanent magnetism is sooner reached the softer the steel. But this is comprehended by the more general one, that the number of necessary repetitions of action of magnetising force increases with the proportion of the attainable remanent moment to the original, already present before action of the force.

Permanent Magnetic Moment of Magnetic Bars, and the Haecker Formula—

$$T = g\sqrt[3]{Q} + \sqrt[6]{l}.$$

—M. L. Külp.—Not suited for abstraction.

Influence of Texture of Iron on its Magnetism.—M. Külp.—Two iron bars of very different structure were experimented with, but the difference in no way affected the amount of the induced moment.

Les Mondes. Vol. xxxvii., No. 12. July 22, 1875.

Magneto-Chemical Phenomena produced within Rarefied Gases in Geissler's Tubes by aid of Induced Currents.—J. Chautard.—See page 45.

Some Experiments on the Electricity of the Thermal, or Hot, Waters.—All the following experiments have been lately repeated at Sorbonne before a meeting of *savants*. They were originally made at Baden on the 15th and 16th of October, 1864, by MM. Thury, Professor at Geneva, and A. Minnich. The instruments used consisted of a galvanometer of 350 turns, insulated according to Professor Colladon's system. The needle made a simple oscillation in fourteen seconds. For electrodes there were used two platinum wires of 26 centimetres long, terminated by two plates of the same metal of 12 square centimetres surface, and soldered to the wires by gold solder. (1). The great thermal source of the Stadthof having been discovered, one of the platinum electrodes was plunged into it; the other electrode was immersed in the Limmat, and was joined to the galvanometer by about 35 metres of thick gutta-percha covered wire. The moment the circuit was closed, the needle, forcibly propelled, described more than a complete revolution, and in a short time oscillated between 74°; afterwards, in proportion as the electrode became polarised by gaseous globules, the reading descended to 72°, 60°, but it immediately rose again to 70° on the platinum plates being cleaned by a brush. This experiment shows that *the hot water escapes from the ground in an electrified condition*, the current going from the Limmat to the source; that is, *the source was negatively electrified*. (2). Two sandstone vases, each of about 6 litres capacity, were placed side by side without touching one another. The first vase, A, was filled with water taken directly from the source, and was still very warm; the second vase, B, was full of cold water from Limmat. The platinum electrodes were introduced into A and B, and circuit completed through a piece of soaked cotton. At once the needle indicated a current from the cold to the hot vase, in the same direction as the current in the other experiment, *the hot mineral water being negatively electrified*. The needle oscillated at first between 44·5°, *gradually decreasing to zero when the thermal water became nearly cold*. The electrodes were then transferred to the other vases, to ascertain whether the weakening of the current proceeded from polarisation of the platinum plates; it was thus discovered that polarisation contributed but very little in that direction. (3). All the arrangements of the last experiment remaining intact, the thermal water, now nearly quite cold, was re-warmed to a temperature of 47° C. (rather higher than that of the source) by means of an alcohol lamp. *No appreciable current, however, was observed on the galvanometer*. Thus, thermal water that has grown cold and is artificially warmed again, has lost its electrical properties. (4). The apparatus as before. The vase A was filled with hot water charged with carbonic acid, and B with cold river water. The galvanometer gave no reading. Thus, *the current observed in* (2) *results neither from a thermo-electric current* (as established in the third experiment), *nor from a particular action of carbonic acid on the platinum electrode*. We briefly referred to these researches in our issue of July 8th.

Journal of the Franklin Institute. July, 1875.

Mechanical Equivalent of Heat.—M. Jules Violle. Translated from the *Revue Industrielle*.—If in friction we see an excellent example of the transformation of work into heat, the inverse transformation of heat into work appears more evident still in thermic engines, especially in those which are moved by steam. Hirn has succeeded in measuring with great exactness both the heat communicated to the boiler of a steam-engine and the total work performed by the engine; but the steam-engine is by no means the only thermic motor employed in the industrial arts. Electro-magnetic engines may also be regarded as thermic machines, deriving their power from the heat evolved by the solution of the zinc in each cell of the battery, and transported throughout the circuit by means of the current. The experiments of Favre* have shown, in a most satisfactory manner, that it is at the expense of a certain quantity of this heat that an electro-magnetic engine produces mechanical work; and in measuring the work

* *Annales de Chimie et de Physique*, III., xl., 293, 1854.

performed, and the corresponding absorption of heat, Favre has obtained another value for the mechanical equivalent of heat, 443. This number differs but little from the exact value. It is also possible to deduce the numerical value of the mechanical equivalent of heat simply by measuring the heat evolved in a wire through which an electric current passes. According to the law of Joule* the heat evolved by a current is proportional to the product of the square of the strength of the current by the resistance of the circuit. Clausius has shown that the coefficient of proportionality is the exact reciprocal of the mechanical equivalent of heat.† If, then, we measure at the same instant the heat which a given current produces, the strength of this current, and the resistance of the circuit, the equivalent sought can be easily calculated. This has been done by Quintus Icilius,‡ who, making use chiefly of Weber's researches,|| has obtained 392 as the equivalent. The difference of this value does not exceed the limits of uncertainty attaching to the use of the large number of constants which it is necessary to determine, and which themselves are not easy to obtain by experiment. Instead of having its origin in the chemical reactions taking place in the cells of the battery, the heat produced by electrical currents may be itself the result of a direct transformation of mechanical work. It is this condition of things which takes place when, by the expenditure of a certain amount of work, a conducting wire is moved in presence of a magnet or of a current. The heating which has been produced under these conditions has been measured by Joule, by means of a tube full of water revolving between the poles of an electro-magnet.§ The number obtained by Joule, 460, is a remarkably close approximation. Le Roux has repeated these experiments, making use of the powerful magneto-electric machines of the Alliance Company.¶ Foucault, had, however, long before, given to Joule's experiment a remarkable form, in which the heating becomes manifest in a very short period of time. Between the poles of a powerful electro-magnet Foucault** placed the rotating disc of a gyroscope. This disc is made of bronze, having a toothed pinion upon its axis, by means of which it was connected with a train of wheelwork, in order to drive it. By means of a crank, worked by hand, a velocity of 150 to 200 turns per second can easily be given to the disc. In order to render the action of the magnet more effective, two pieces of soft iron—placed above the bobbins—lengthened the magnetic poles and concentrated the force in the vicinity of the rotating body. When the apparatus is put in motion with a high velocity, the current of six Bunsen cells passed through the electro-magnet arrests the rotation in a few seconds, as if an invisible brake had been applied. This is really the experiment first made by Arago,†† and developed by Faraday. If now the crank be forced to turn, in the attempt to give to the apparatus its former velocity, the resistance encountered requires the application of a certain amount of power, which, disappearing as such, accumulates effectively as heat in the interior of the revolving body. By means of a thermometer inserted in the disc the progressive elevation of the temperature may be followed step by step. Having taken, for example, the apparatus at the surrounding temperature of 16° C., the thermometer was seen to rise successively to 20°, 25°, 30°, and 34°. Then the phenomenon had become so developed as not to require the use of thermometric instruments. The heat produced was sensible to the hand. Some days afterward, the battery being reduced to two cells, a flat disc made of copper was raised in temperature, during two minutes of motion, to 60°. Two conditions only are necessary and sufficient to make it certain that the heat evolved in this experiment is the exact equivalent of the work expended in maintaining the rotation uniform:—1. It is necessary that the disc should be, at the end of the experiment, in precisely the same condition as at its beginning. 2. It is necessary that the heating of the disc should be the only effect produced. Both these conditions are satisfied in the experiment. But a serious objection presents itself,—an objection which Joule himself first suggested, and by which he accounted for the disagreement of his experiments with this method. We have, in fact, neglected, up to the present time, an intermediate phenomenon: the motion is transformed into heat only by means of electricity. The immediate action of the electro-magnet upon the disc when in motion is to develop in it, by induction, electric currents; and it is these currents which heat the disc. If, however, it were true that the work expended to maintain the rotation of the disc was transformed entirely into electricity, is it quite certain that all this electricity is transformed into heat? In order that it may be, it is necessary that the heating of the disc be the only effect produced by the currents. But even if the currents thus generated within the disc do not cause either luminous phenomena or perturbing mechanical effects, have we not to fear that they will give rise to phenomena of induction, thus creating by their influence electric currents in the two polar masses of the electro-magnet? By experiments specially instituted to test this question,* Foucault has shown that as soon as the velocity of the disc becomes uniform there are no induction-currents circulating in polar masses of the electro-magnet, and hence, consequently, there is no reaction between the disc and the electro-magnet. These results have since been confirmed by direct experiments made by Jacobi.† In every experiment, as soon as the disc attains the uniform velocity which is maintained throughout, the electric currents which are developed by induction in this disc maintain a constant intensity, and preserve in space a constant position. These currents may therefore be considered as absolutely fixed so soon as equilibrium is reached. It is the displacement of the material of the disc with reference to these currents which produces the heating which is observed. But if the currents do not change, either in strength or in position, there certainly can be no effect of induction produced on external conductors,—a conclusion which direct experiment fully confirms. In consequence of these facts the author was led to the belief that he could employ advantageously Foucault's apparatus for measuring the mechanical equivalent of heat.‡ And by means of it, using discs of various metals, he obtained with copper 435·2, with tin 435·8, with lead 437·4, and with aluminum 434·9. The experiments made with the discs of copper and of aluminum being worthy of more confidence than the others, the author proposes 435 as the mechanical equivalent of heat.

* *Philosophical Magazine*, III., xix., 260, 1841.
† *Poggendorff's Annalen*, lxxxvii., 415, 1852.
‡ *Poggendorff's Annalen*, ci., 39, 1857.
|| Weber, "Electro-dynamische Maasbestimmungen." (*Mem. de la Soc. Royale Saxonne de Sciences, Leipzig*, 1856, tome v.)
§ *Philosophical Magazine*, III., xxiii., 263, 434, 435, 1843.
¶ *Comptes Rendus des Séances de l'Academie des Sciences*, x., 414, 857
** *Annales de Chimie et de Physique*, III., xlv., 316, 1855.
†† *Annales de Chimie et de Physique*, II., xxiii., 213, 1826.

* *Annales de Chimie et de Physique*, September, 1870.
† *Comptes Rendus des Séances de l'Academie des Sciences*, January, 1872.
‡ *Comptes Rendus des Séances de l'Academie des Sciences*, June, July, 1870.

COMMERCIAL NOTES.

A PROSPECTUS has been issued by the directors of the Eastern Extension, Australasia, and China Telegraph Company, offering 3200 debentures, amounting altogether to £320,000, at £100 each, and bearing interest at the rate of 6 per cent. This amount is required to provide the cable which is to connect Australia with New Zealand. Shareholders are allowed the option of subscribing in the first instance.

At the special general meeting of the Western and Brazilian Telegraph Company, held at the Cannon Street Hotel on Friday last, the chairman said he had to submit three resolutions. They were for the purpose of enabling

the company to fulfil its obligations, specified in an agreement dated May, 1873, between the company and the River Plate and Brazilian Telegraph Company. The company had debentures to the amount of £250,000, of which about £201,800 were issued. The company's repairing ship had cost £30,000, her fitting-up a further sum, and the spare cable on board was worth £15,000. They proposed that the reserve fund should pay for the ship, which would for the present represent the reserve fund. Resolutions were adopted enabling the directors to increase the capital of the company by the addition of £48,200, divided into 69,910 shares of £20 each. A resolution for the purpose of giving further borrowing powers to the board, but without thereby increasing the present debenture issue, was also agreed to; the borrowing power is not, however, to exceed £60,000 current at one time.

The half yearly interest on the debentures of the Western and Brazilian Telegraph Company, Limited, due on the 1st proximo will be paid on and after that date at the offices of the company.

The estimated gross receipts of the Anglo-American Telegraph Company for the 21st inst. amounted to £1570, on the 22nd to £1600, on the 23rd to £1500, on the 24th to £1400, on the 25th to £350, on the 26th to £1120, and on the 27th to £1590, against an actual average, in July, 1874, at 4s. per word of £1826.

TELEGRAPH SHARE LIST.

Amount per Share.	NAME OF COMPANY.	Amount paid up.	Closing Quotations.
£		£	July 28.
Stock	Anglo-American	100	65¼—65¾
10	Black Sea	All	2—4
10	Brazilian Submarine	All	6⅝—6⅞
10	Cuba	All	7¾—8¼
10	Ditto, 10 per cent Preference ..	All	13½—14
10	Direct Spanish	9	4¾—5¼
10	Ditto, 10 per cent Preference ..	All	10½—11¼
20	Direct United States Cable	All	7½—8
10	Eastern	All	6⅞—7⅛
..	Ditto, 6 per cent Debenture	..	103—106
10	Ditto, Exten. Australia and China	All	7¼—7¾
10	German Union Telegraph and Trust	All	7¾—8¼
10	Globe Telegraph and Trust	All	5¾—6¼
10	Ditto, 6 per cent Preference	All	10⅛—10⅝
10	Great Northern	All	9½—10
25	Indo-European	All	19—21
10	Mediterranean Extension	All	2¾—3¼
10	Ditto, 8 per cent Preference	All	10—10½
10	Panama and South Pacific	2½	..—..
8	Reuter's	All	9½—10½
Stock	Submarine	100	195—205
1	Ditto, Scrip	All	1¾—2
10	West India and Panama	All	2½—3
10	Ditto, 10 per cent Preference ..	All	10½—11
20	Western and Brazilian	All	13½—14
1000 dls.	Western Un. U.S. 7 per cent 1st M.B.	All	106—108
100	Ditto, 6 per cent	All	89½—90½
10	Hooper's Telegraph Works	All	8½—9
50	India-Rubber and Gutta-Percha ..	All	18—20
Cert.	Submarine Cables Trust	100	95—99
12	Telegraph Construction	All	23—24
100	Ditto, 7 per cent Bonds	All	101—104

PATENTS.

APPLICATIONS FOR LETTERS PATENT.

2518. Sir Samuel Canning, Knight, civil engineer, Great Winchester Street Buildings, London, and Henry Francis Joel, engineer, Lavender Grove, Dalston, Middlesex, for an invention of "Improvements in pneumatic signalling or communicating apparatus, and in the mode of and apparatus for testing the transmitting tubes for the same, applicable also to the testing of gas and other pipes or tubes."—Dated July 13, 1875.

2546. Matthew Smith and Michael Holroyd Smith, wire manufacturers, both of Halifax, York, for an invention of "Improvements in apparatus to be employed for annealing wire and continuous strips of metal, and for heating for the purpose of hardening and tempering the same."—Dated July 15, 1875.

2564. Theophile Adolphe Hequet, engineer, Paris, France, for an invention of "Improvements in electro-magnets."—Dated July 17, 1875.

NOTICES TO PROCEED.

995. William Nickson Haggard, of the firm of Haggard, Brothers, and Co., tea merchants, 3 and 4, Fowkes Buildings, London, has given notice in respect of the invention of "Improvements in electro-magnetic signalling apparatus."

2286. Thomas Glazebrook Rylands, and Israel Swindells, analytical chemist, both of Warrington, Lancaster, have given notice in respect of the invention of "Improvements in the mode of recovering certain chemical products from the waste products obtained in the processes of galvanising iron."

Wimbledon and the Telegraph.—It is but a year or two ago since the Post Office established a complete telegraph service in the Camp at Wimbledon. Yet the growth of the business, as evidenced by the work done in connection with the recent meeting, has been somewhat remarkable. In 1872 some 3000 messages, and less than 80,000 words of news for the press, were transmitted from the Camp, as compared with upwards of 5000 messages and 165,000 words of news transmitted during the past fortnight. On the day of the International Match as many as 630 messages and 20,000 words of news were transmitted; but there were other days of the meeting when the press work was even heavier, as, for instance, on the second day, when it reached 22,000 words, and on the fourth day, when it was just under that number. A new feature was introduced into the arrangement this year by the adoption of the Wheatstone automatic instrument for the rapid disposal of press messages. This apparatus is peculiarly adapted to the kind of telegraph work which arises in connection with the Wimbledon meetings, as the elaborate scorings, after being once prepared on the perforated paper, can be used for the transmitting machine any number of times. By this means press messages were sent direct from the camp to London, Manchester, Birmingham, and other towns on each day of the meeting, and a form of apparatus new to the Camp office was regarded by the officials of the Association and the press correspondents with peculiar interest. Three wires, made equal to four by the use of the Wheatstone apparatus, were constantly at work at Wimbledon during the meeting, and five clerks of the special telegraphic staff of the Post Office laboured incessantly from early morn until "lights out," and sometimes even later, to keep down the mass of work which flowed into the office. The telegraph and post offices adjoin each other in the building occupied from year to year by the Royal Engineers and other officers of the National Rifle Association, and both have become indispensable adjuncts to the machinery of the great volunteer gathering.—*Standard.*

TO CORRESPONDENTS.

*** Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which "THE ELECTRICAL NEWS and TELEGRAPHIC REPORTER" is the organ, will always command attention. Literary communications and books for review should be addressed to the EDITOR; business communications to the PUBLISHER, Boy Court, Ludgate Hill, London, E.C.

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THE ELECTRICAL NEWS

AND

TELEGRAPHIC REPORTER.

EDITED BY WILLIAM CROOKES, F.R.S., &c.

TO ELECTRICIANS EVERYWHERE.

Since the day when Electricity was first discovered, until now, its vast importance and its high destinies have grown upon the human mind. Fresh phases of its power, fresh results, new means of obtaining and governing its action, and multiplied ends to which it may be turned, have constantly discovered themselves; till to-day it stands out as one of the grandest subjects presented to the scientific and practical world for investigation and research. Perhaps, however, no other Science or Art has exhibited so extraordinary a concurrence of anomalies. It is at once the most terrible monster and the most humble and obedient servant, its action is at one moment beneficial, at the next destructive; its range is boundless, yet it may be "cabined, cribbed, confined" at ease; it is everywhere present, while its nature is only imperfectly understood; and, to crown all, although it is one of the most important agents in the action and the phenomena of the universe, and increasing knowledge of its applicability to the needs of our race is of the utmost importance, no direct means of ascertaining the thoughts and discoveries of its students, or of bringing them before the scientific and mechanical community, at present exist. Attempts have been made to supply this want, and journals have been started with the professed object in view of making public all that is known or can be learnt of Electricity in all its branches. But they have degenerated into unscientific records of unimportant events, and the purpose for which they were established has been lost sight of. Thus it comes that—while Engineering, Chemistry, and other Applied Sciences have all their representative recognised organs—the Electrician finds himself without any current journal from which he can learn the events which are daily occurring of peculiar interest to himself.

Such a want has now been supplied by the establishment of the Electrical News and Telegraphic Reporter. In its columns will be found the most valuable opinions of eminent Electricians and scientific men all over the world. Articles will be contributed which will be of value not only to those who study Electricity as amateur experimentalists or scientific inquirers, but also to those whose daily life is bound up with the advancement of practical knowledge in all departments of the science, and who as electricians, telegraphists, electrotypers, electroplaters, and chemists have continually to deal with the same marvellous agent of force in different ways. Nor will the doings of foreign societies be ignored as in times gone by, but, in the shape of carefully prepared abstracts, their proceedings will be presented to our readers. Every opportunity will be given for the healthful discussion of the science in all its branches, and a fair unbiassed course will be steered in all questions of dispute.

This, then, is our Programme in brief. More we could promise, but prefer to let the new periodical speak for itself. The subject with which it will deal is of too great importance to need one word of recommendation. Daily experience teaches us that we are as yet on the threshold only of a vast expanse of electrical knowledge. This has to be explored, and as the research gains in strength and intelligence the results will be far beyond all present conception. The feat of girdling the earth in forty minutes will be eclipsed by great deeds yet to be done, and if the establishment of the Electrical News and Telegraphic Reporter conduces to the hastening of this desirable end our object will have been gained, and we shall be fully rewarded.

Boy Court, Ludgate Hill, London, E.C.
July 1st, 1875.

London: Printed and Published by the Proprietor, William Crookes, at the Office, Boy Court, Ludgate Hill, E.C. July 29, 1875.

THE

ELECTRICAL NEWS

AND

Edited by *Wm. Crookes, F.R.S., &c.*] TELEGRAPHIC REPORTER. [*Registered for Transmission Abroad.*

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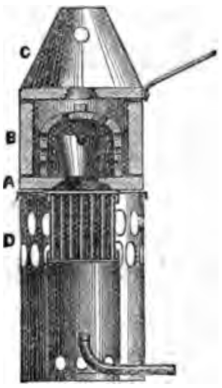

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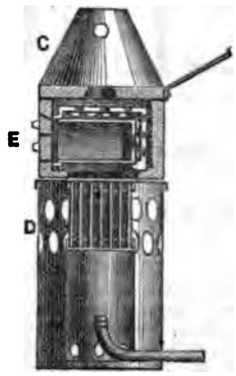

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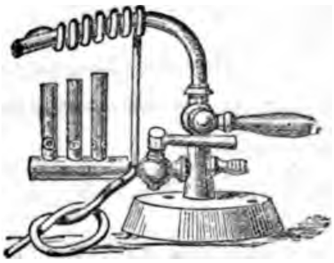

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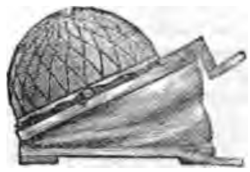

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THE ELECTRICAL NEWS.

Vol. I. No. 6.

ON THE CHANGES OF TEMPERATURE WHICH OCCUR IN PASSAGE OF AN ELECTRIC CURRENT FROM ONE METAL TO ANOTHER.

The temperature-effect here denoted differs from that in passage of a current through a homogeneous conductor, inasmuch as it may be a cooling as well as a heating. The phenomenon was first observed by Peltier, in 1834.

Poggendorff showed that it must be closely connected with thermo-electricity, for heating took place at the junction point of the two metals, if the galvanic current flowed from the positive to the negative metal (according to the thermo-electric series), *e.g.*, from antimony to bismuth; and cooling, if it flowed in the opposite direction. Thus it appeared that in the circuit wire there was a thermo-electric excitation, the direction of which was opposite to that of the hydro-electric current.

The experiments of Quintus Icilius on this subject in 1853, and those of Frankenheim shortly after, have been revised and criticised by Dr. Buff, in a recent instructive paper to *Poggendorff's Annalen*.

Quintus Icilius made a galvanic current of known strength pass, for thirty seconds, through a thermo-electric battery of antimony and bismuth bars. Thus opposite changes of temperature were produced at the odd and the even solderings, and the effect of these was measured galvanometrically. From the observations it was inferred that the differences of temperature of the odd and even solderings remained independent of the absolute heating of the metals, and were in direct proportion to the strength of the producing current.

There was, however, a slight but distinct increase of the quotient of thermal effect by strength of current, as the latter was increased. This Quintus Icilius recognised, but did not explain.

Dr. Buff arranged his experiment thus:—Using a very sensitive astatic galvanometer, he did not require more than a single pair of cylindrical bars (5 m.m. thick). These were planed and bound together with the flat surfaces opposed. To the outer ends thick copper wire was soldered, through which first the principal current was passed (thirty seconds), then, by a quick transference, the wires were connected with the astatic galvanometer. The thermo-electric couple was placed under a metallic vessel, to avoid currents of air. A careful comparison was previously made of the indications of the astatic galvanometer with those of the tangent compass in the primary circuit. A deflection of 1° in the former being regarded as proportional to deflecting force 1, it appeared that up to 21° the deflecting force might be measured by the amount of the deflection. For greater deflections a necessary correction was made.

The general result was a gradual increase of the proportion of thermal effect to the strength of the principal current; thus it might seem that the temperature changes at the transition surface of two metals in contact were approximately, but not exactly, proportional to the strength of the producing current. Dr. Buff finds an explanation of this. "The thermal effects," he says, "at the different points of junction of a thermo-electric battery, which take the form now of heating, now of cooling, and which we may denote by y, are always accompanied by heat actions, which are dependent on resistance to conduction, and, it is known, are proportional to the square of the strength of current. This second kind of actions, which we may call x, are of course without influence on the galvanometer, when they are of equal strength at all the points of junction; on the other hand, when the places of contact are of unequal nature, they must become more and more perceptible with increasing strength of current, for their unequally active influence increases with the square of the strength of current, while that of y increases only in direct proportion to it. Now such inequality was undoubtedly present in the thermo-electric pair described; for at the two ends copper wires were soldered, while in the middle antimony and bismuth were only touching each other with plane surfaces, though of course pressed together. To remove any such disturbing influence, as much as possible, two bars were now soldered together with easily-fused metal, and the experiment repeated as above."

From the numbers given in a table it is shown, that through this intimate connection of the two bars, and the increase of points of contact at the bounding surface, the irregularity referred to is completely removed (at least within the limits of current strength selected). Hence the author considers it demonstrated that "the change of temperature in passage of the electric current from one metal to another obeys the law of proportionality to the strength of current more exactly, the more completely other causes of excitation of heat at the place of contact are excluded."

Frankenheim (as above stated) also studied this subject. After trying various modes of experiment, he finally decided to use Peltier's cross; which consists of two bars, bismuth and antimony (or the like), laid crosswise one on the other, and soldered together. Two neighbouring ends are connected with a galvanic battery and tangent compass, the two others with an astatic galvanometer.

Frankenheim considered that at the crossing point there were two heat effects; that due to ordinary resistance, and that dependent on passage from one metal to the other. The former (x) was independent of direction of the principal current; the latter (y) changed sign if the direction of current were reversed. Hence two equations $x+y=a$, and $x-y=b$, with the aid of which both x and y could be deduced from proper experiments.

Dr. Buff considers that Frankenheim's experiments are invalid, because he sought to measure the temperature of the crossing point while the principal current was passing. (He held the other method liable to mistakes which did not allow of being calculated. The nature of these mistakes he did not explain).

Frankenheim, again, thought the current measured by his astatic galvanometer purely the effect of thermo-electric action. But (Dr. Buff says) it is really in great part a branching of the principal current. In repeating the experiment it will be found that the action on the double needle occurs with the greatest part of its strength immediately after closure of the principal circuit. If we measure the amount of the first deflection, then interrupt the secondary circuit, and renew the experiment after the needle has come to rest, we generally observe only a slight change in the amount of the deflection from that first noted. A thermo-electric excitation must, doubtless, meanwhile occur; but it can only be made distinctly perceptible after exclusion of the principal current, and by shortening the circuit of the thermo pile. Again, a mere momentary action of the principal current proves insufficient to produce, afterwards, a distinct deflection of the double needle; whereas, the galvanic circuit being kept closed for some time, there is a gradually increasing deflection of the double needle. (Dr. Buff mentions other facts as indicating that in the secondary circuit of the Peltier cross a branch of the principal current is present in considerable quantity).

If, now, in an antimony-bismuth cross, the principal current goes from antimony to bismuth, its branch z pursues its course through the antimony bar forwards; and the same direction is taken by the thermo current depending on x and y, since the place of contact is heated by both influences. Hence the action on the galvanometer is expressed by the equation $A=x+y+z$. If the principal current is sent in the direction bismuth to

antimony, the branch current z goes onwards in the bismuth bar, and unites in its progress to the galvanometer with the thermo current due to the electro-motive action y, for this now goes from bismuth to antimony. On the other hand, the electromotive force x, *i.e.*, the heat effect dependent on resistance at the place of contact has its former direction from antimony to bismuth. The whole action on the needle is accordingly now expressed by the equation $B = x - y - z$. We thus see that the equations A and B are well fitted for determining x, but that z and y do not allow of being separated. Hence what Frankenheim found proportional to the strength of the hydro-electric current, was really a branch of the latter.

Dr. Buff experimented with the Peltier cross thus:—The principal current (with three different strengths) was made to circulate alternately from antimony to bismuth and in the opposite direction, for thirty seconds. Then the circuit was broken, and in the same moment the thermo circuit closed. The cylindrical bars were at first merely in contact, with moderate pressure.

The direction of the deflection was in all cases the same, and corresponded to a heating of the crossing point. The values of x and y were in each case calculated, and they are seen to be sufficiently near to the law above stated to exclude any other combination.

It seemed desirable to alter the cross so that the electromotive force y might have greater influence; this was done by pressing the bars firmly together with planed surfaces in contact. In consequence of this arrangement, the astatic needle changed its direction as often as the principal current went, before interruption, in negative direction, *i.e.* from bismuth to antimony, and therefore produced a fall of temperature. Yet it was evident that the heating of the place of contact due to resistance to conduction, which had only a small influence in the case of weaker currents, quickly increased with the currents till it became equal to the action y, and would even have exceeded it. A prolonged time of action operates in the same direction.

Similar observations were made with the two bars soldered together, and the expectation that the heat action due to resistance would thus be more prominently brought out was confirmed. Apart from the fact that this method enables one to completely separate x and y, the soldering of the bars (Dr. Buff remarks) gives no advantage. The heat developed in the two branches of the cross, through which the principal current circulated, was brought to the point of contact more quickly than in the previous experiments, and so the action of cooling could not reach its full development.

The phenomenon of heating and cooling at the place of contact of two metals, according to the direction of the current, has not hitherto had any satisfactory explanation. Dr. Buff supposes it due to the same cause, as many physicists consider the source of thermo-electric currents, namely, the thermo-electric excitation, and a corresponding thermo-electric difference at the place of transition between two heterogeneous metals. He enunciates the law that the liberation of heat is in proportion to the quantity of electricity put in circulation in unit time, multiplied by the electro-motive force of the battery. At each transition point between one metal and another, a thermo-electric exciting force is manifested of the same or opposite direction to the propelling force of the circulating current. If the latter, *e.g.*, is compelled to pass over from antimony to bismuth, it finds a resistance at the limit of the two metals; for, at this part, a continuous excitation prevails to set in motion an electric current in the direction from bismuth to antimony. This resistance, added to the resistance to conduction also present, results in accumulation of the electric force at the part in question, and so a development of heat. This increase of heat at the junction surface of the metals, if compared with that at any other part of the same circuit, is in proportion to the electro-motive action at both parts. It is therefore proportional to the strength of current, and not to the square of this.

If the electric current passes from bismuth to antimony, the exciting force at the limiting surface of the two bodies has the same direction with the motion of the electricity. This force therefore comes to be deducted from the force necessary to equalising of the ordinary resistance. Thus it may happen that the resistance at this part not only disappears, but even acquires a negative value.

CAUSES OF DESTRUCTION TO WOODEN POSTS.

By M. BOURSEUL,
Sub-Inspector of French Telegraphs.

(Concluded from page 41).

I have often observed on razed trees upon which the bark has been left that the *blea*, or inner bark, has withered; consequently the fibres of the wood tend to close up to each other, whilst the drier and harder core preserves its volume; the *blea* splits, and the bark opens. From the surface the germs of destruction are washed away by rain, or carried off by wind; but in these interstices they lodge, fructify, and in a short time produce the fungus. The same thing naturally takes place when two pieces of wood are brought together.* In depôts poles are placed horizontally one upon the other: if they remain too long in the same position, *even when they do not lie immediately upon the ground*,—if they are exposed to rain, or, being covered, if they are in the shade in a damp, badly-aired spot, the fungus asserting itself soon develops at all the points of contact between the poles. Should care not be taken, and the poles be planted in that condition, it will not be long before they perish: cross-beams should therefore be mistrusted in telegraph poles, &c.

When, under exceptional circumstances, poles are obliged to be left stored in a depôt, they should be turned from time to time, so as to change their points of contact and successively expose their different parts to the light; and when the fungus has begun to develop itself, it is indispensable that the afflicted part be cauterised, either by fire or by sulphuric acid.

When once the *Merulus* attacks planted poles it is very difficult to preserve them. The moment the authorities charged with the surveillance of the line observe at the foot of a pole the existence of those filaments which denote white decay, they should lay bare its foot until they meet with no further trace of mycelium in the soil; the whole of the infected earth should be thrown to a distance, and every bit of contaminated wood should be taken away by the help of a cutting tool.† Then burn shavings or branches, and replace around the pole earth as compact, clayey, and free of air as possible. Alternate layers of clay mixed with water, of slates, or flat stones, will compact the whole together, and form a kind of natural concrete, often sufficient in itself to completely preserve the wood.

Because the fungus, in order to vegetate, requires access to the atmosphere, it is not developed below a certain depth, varying from 30 to 50 c.m.,‡ according to the nature of the soil. In grounds where the wood is usually attacked we must—without waiting till the "rot" has commenced—renew the earth at intervals, and well ram it down. The best instrument will evidently be the least weighty one, and one which, without burying itself in the soil, possesses the least possible surface.

By turning over and renewing the earth at intervals all

* In double poles the cross-beams are coupled with each of the poles, and therefore the same results may be expected.

† A cutting spade, straight, but rounded a little towards the end, serves this purpose very well.

‡ The existence of the mycelium has been observed underground as far as to a depth of 3 metres. But this instance of giantism must be considered as thoroughly exceptional.

injurious vegetations are destroyed; and for the same reason brambles must be removed, as also shrubs, since these not only produce an injurious effect by their roots, but they hide the foot of the post from the light, hinder circulation of the air, and maintain a constant dampness.

These operations will considerably retard the destruction of timbers, and will very often preserve them from "rot." It must not, however, be denied that it is very difficult to combat the fungus when once the pole is attacked; and to make sure of guarding against it, the surface of the wood must be entirely isolated from the water and air which surrounds it. To this end a hole is made around the pole, in the form of a reversed cone, to a depth of about 50 c.m. This hole is filled with concrete or cement, and the block is capped above the level of the soil by an inclined surface, upon and from which the rain water glides. The joints near the timber should be attended to with exceptional care.

Iron muffles used for the same purpose are dear; moreover, for reasons to be hereafter detailed, their use offers serious inconveniences. I have obtained very satisfactory results by first coating, with coal-tar or with paint, all those portions to be preserved, and afterwards covering them with a sheet of zinc, soldered to the joint, and firmly fastened above and below.

The line overseers have often assured me that the raising posts always rot in a greater proportion than ordinary supports. At first this seemed impossible: but it admits of easy explanation. These posts are most often placed close to culverts which lead to property on the banks of a river. The lime and sand used in their construction mix with the surrounding soil in quantities sufficient to cause wood-rotting,—an action which is also facilitated by an alternate dryness and moisture, resulting from the close neighbourhood of the trench. We should therefore be careful not to plant wooden supports too near culverts or arched drains.

We ought equally to abstain from the fashion of planting a new pole in a hole from which a rotten one has been taken. The germs of destruction being close at hand, the second pole will perish yet more rapidly than the first.*

The practice of breaking off rotten poles level with the ground is very bad. They should be plucked out entire; the diseased parts should be burnt or carried away; the old hole should be filled up, and rammed down; and the new pole should be planted at least a yard from the locality of the old one. If rotten sleepers or cross-beams and the ends of posts are left about, the filaments of the mycelium —in light or cracked soil—force their way through the ground in a manner and to a distance one would have deemed impossible, and will soon invade unaffected localities.

It may be remarked that when once a pole has been injured by wet-rot, if it be carefully taken up and all the rotted portions sawed away, and if it be replanted at a sufficient distance from its former position, it will not, in a usual way, be long serviceable: it will soon recommence to perish, as it is almost impossible to prevent some destructive germs remaining in the fissures of the wood. The evil is greater still if, instead of replanting the wood at once, it be left exposed for a certain time to the air. In such a case it is not worth its carriage. Once replanted, it almost always perishes with very great rapidity.

If I have succeeded in laying bare the nature of the evil to be fought against, we understand how much easier it is to be prevented than to hunt it away when once it has made its appearance. It seems to me almost certain that among the numerous coatings known and used to prevent dampness, one can be found capable of preserving buried woods; and supposing, which is very probable, that this coating would require to be renewed at longer or shorter intervals, its use would still effects a considerable saving.

Coal-tar has not been successful. I have reason to believe that it has not generally been well applied. The tar ought to be used hot, though it should not be allowed to boil too long, lest it lose the essential oils which alone assist it to enter into the wood, and lest it become reduced to a substance in all points resembling bitumen. The wood should be well heated. By this means moisture is dispersed, the pores are opened, and the material by penetrating forms an adhering and resisting layer. A single thick layer has a very bad effect; repeated and light layers should be given, though it is a difficult operation. For want of following out these precautions we simply lay on the wood a coating which is separated from it by moisture, and is of a brittle, cracking, and splitting character. Under these circumstances all the destructive agencies penetrate by the splits, and the wood is attacked as though it had been in no way treated. The best method of carrying out these requirements is first to heat the wood, then immerse into a bath of cold mixture the portion to be buried, and to leave it there for twenty-four hours at least; afterwards the tar should be raised to the point of boiling. After the operation is completed, if it be wished to facilitate the sap's motion, the pole might be shortened by some centimetres at the lower end, so as not to have an impervious bottom.

Carbonisation, better applied than it is, should give very good results. In raising the wood to a suitable temperature the fermentable substances coagulate, the foreign organisms are killed, the spores and the mycelium are disorganised. But it is better to imperfectly burn the wood—to scorch or roast it. When the carbonised layer is too thick, and has lost its consistency, it splits, breaks during carriage, so as to leave the interior wood exposed to the air. I have tried to obtain a thin and very uniform layer by drenching the wood with a solution of sulphuric acid and water (five parts of water and one of acid), and by lightly heating it without direct exposure to the flame. The more acid in the water the less heat is required. In order to obtain a good solid layer it is preferable to warm the wood for a longer time, at a lower temperature. This system is deserving of greater trial, since the sulphuric acid permeates to a certain depth into the wood, and there exercises an action destructive to the fungus.

I now return to the question of *dry rot*, to which reference was made at the commencement of my paper.

Dry rot is infinitely more easy to combat with: it acts very slowly; it is not necessarily accompanied by a vegetable production; and it is not contagious. If rotten wood of this class causes other woods to rot, it is wholly on account of the nature of the residuum. *Mould, black decay*, is very hygrometric. It divides the surrounding soil, maintains moisture in it, and readily facilitates the introduction of air. Standing trees may be attacked with dry rot, either on their surfaces or in their interior. Very old trees are very frequently found whose outer and inner barks are full of holes, with spaces between their two concentric layers; and if the tree be sharply struck, a brown powder—*humus* or *mould*—falls down. Wrought wood, when it is attacked by this rot, is easily preserved. It is sufficient to entirely take away or cauterise the part affected, and afterwards to give the wood a coating. The action—very slow by itself—is thus retarded, so as to produce henceforth but insignificant damage.

But dry rot acts upon telegraph poles under special conditions which may be instructively specified.

It has already been stated that at the point of contact between two pieces of wood wet rot is readily produced; that such wood being used runs the risk of perishing and destroying that which it touches. One imagines, besides, that when earth is vigorously stirred for a great surface, it is so much more aërated and lightened, and consequently rendered fit for the development of injurious vegetations. All these conditions are combined oftenest in a coupling of two poles; therefore no room is left to woo-

* These observations show that the problem of the preservation of telegraph supports becomes more and more difficult to settle, for every day the quantity of matter in decomposition which may accelerate rot increases in ground in close proximity to railways, as much from the decomposition of the sleepers which support the rails as from the rot of the first set of poles planted.

der that two poles thus coupled are destroyed much more rapidly than are ordinary ones. There is, moreover, another cause of destruction, and one much more frequently met with.

I have often assisted in repairing expeditions for the purpose of determining both the manner of deterioration and the precise conditions under which it takes place. I have noticed that not only did the greater number of posts replaced belong to those coupled, but that nearly all of them were attacked in just the same manner. The iron bolt fixing the arm to the post is the true cause of the havoc done.

Although the hurtful action of iron on wood is well known, I consider it useful to recall to mind how the injury is produced. In a damp medium, and in the presence of air, iron rusts and forms a sesquioxide of iron. On contact with organic matters this product is deoxidised—the sesquioxide yields its oxygen to the hydrogen of the wood, and passes to the condition of protoxide. But this latter compound rapidly absorbs the oxygen from the air, and re-forms itself into sesquioxide, which acts anew upon the wood. The sesquioxide is thus a regular oxygen storehouse, which on one hand empties itself to the injury of the wood, and on the other refunds itself from the atmosphere: it thus acts as a very energetic and continuous oxidising body, so that literally the iron burns the wood.

In this particular case sulphate of copper is more injurious than useful to the preservation of the timber, for the very simple reason that in presence of iron it becomes transformed into an iron salt: which has been recently proclaimed eminently destructive to wood.

Whatever it may be, here are the exact records of deterioration produced by iron on a post injected with sulphate of copper, chosen from a great number of the same class. The iron bolt remained firm in the core of the wood; above and below this bolt, in the direction of the timber's fibres, and to about 50 c.m. on either side, the wood was completely eaten away. On the right and left, in a transverse direction, the decay extended 10 c.m., and to a depth of 5 to 6 c.m. On sawing a pole thus decayed, at different heights, it was ascertained that the section, in the portion which corresponds to the destroyed fibres, had partially retained its consistency, but was of a brownish-black stain to a distance as great as 1 yard from the bolt. When the coupled posts were planted on a slope, the arm being horizontal, one of the bolts was more exposed to the air than the other, and its corresponding pole was more attacked than the other. There can thus be no doubt as to the real cause of the phenomenon. I therefore think that coupled poles should be avoided; and that where double poles are indispensable, they should be constructed—as far as possible—without arms or crosss-beams.

It is preferable to surround a pole with a block of cement of triangular prism form. One of the faces—whose width should vary according to the resistance to be overcome—should be perpendicular to the resultant of the wire-tensions, and this prism, leaning in this manner against a sufficient surface of soil, will maintain the pole in its vertical position.

Unless from exceptional circumstances the inclined pole cannot sink into the ground; the vertical pole tends to rise under the action of the wires. This movement may be avoided, and the post retained in position by means of a block surrounding the lower part of the vertical pole. A band of iron twisted round the exterior of each of the two poles, to each of which it is solidly fitted by two screws, will prevent them from giving way, and completes this system of coupling. If circumstance permit the inclined post to be consolidated into its seat, it may likewise be surrounded with a block of cement.

The total number of messages forwarded from Postal Telegraph Stations in the United Kingdom during the week ended the 31st July, 1875, was 463,360; during the corresponding week of 1874, 408,286; showing an increase in the week of 1875 on that of 1874, of 55,074.

SIR WILLIAM THOMSON'S METHOD OF DEEP SEA SOUNDING BY PIANOFORTE WIRE.

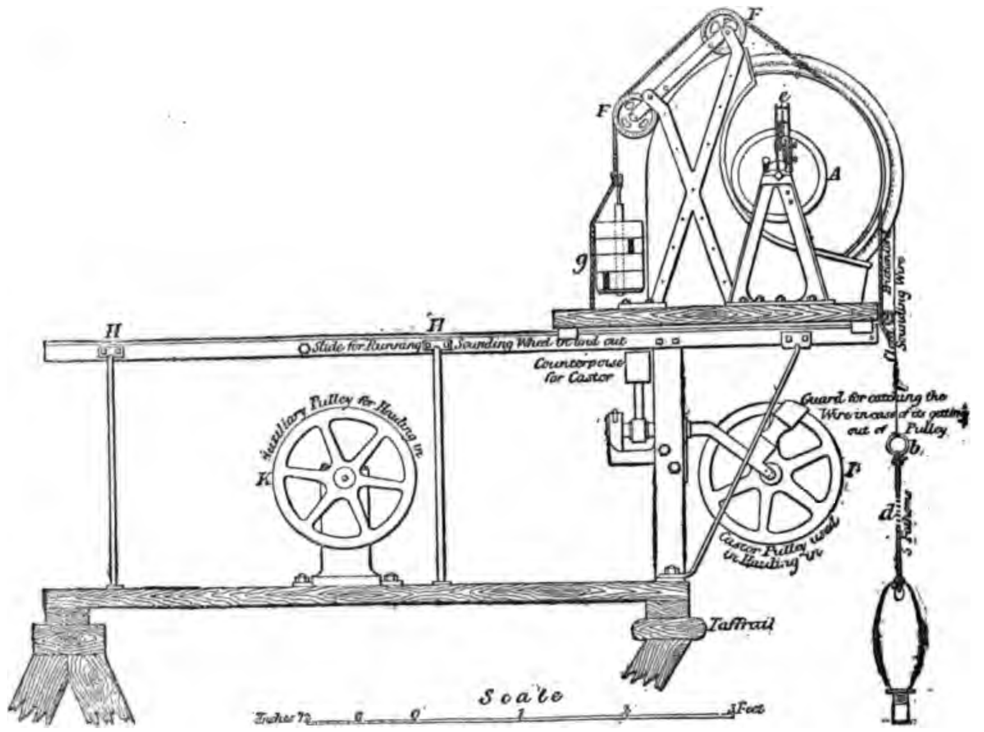
On the 22nd of April, 1874, Sir William Thomson delivered a lecture before the Society of Telegraph Engineers, on his new method of deep-sea sounding by means of pianoforte wire. In that admirable lecture Sir William showed that the great merit of wires compared with rope is the smallness of the area and the smoothness of the surface which the wire presents, as compared with the greatness of the surface and its roughness when rope is used with a comparable degree of strength. Pianoforte wire, of the Birmingham gauge No. 22 has been found most suitable: it weighs about 14½ lbs. to the nautical mile, and bears from 230 to 240 lbs. pull without breaking. Messrs. Johnson produced a length of 3 miles, in one piece of crucible steel, capable of bearing a strain of about 230 lbs. One of the greatest difficulties to be overcome was the splicing of the wire. Experiment showed that a splice of 2 feet long was sufficient, but 3 feet may be safer. The two pieces of wire to be spliced are laid together, and held between finger and thumb at the middle of the portions thus overlapping. Then the free foot and a half of wire on one side is bent close along the other in a long spiral, with a lay of about one turn per inch, and the same is done for the free foot and a half on the other side. The wire has been previously coated with marine glue, just to increase a little the surface friction. The wires are found to cohere perfectly when splices are made in that way, all that is necessary to make the splice permanent being to cover the ends over for about an inch with a serving of twine just to keep the ends firm down.

The sounding apparatus as it is now finished and sent out by Mr. White, of Glasgow, and as it has been used by the screw-steamer *Faraday* on the Direct United States Cable Expedition, is represented in the accompanying figure, for which, with the description, we are indebted to the editor of *Engineering*. It consists of a large light drum, A, of galvanised sheet iron, on which the wire is carefully coiled. The free end of this wire terminates in a stout galvanised iron ring, *b*, and to this ring the sinker *c* is attached by a hemp line, *d*, several fathoms long. The interposition of the line between the wire and sinker prevents the wire from reaching the bottom, and the ring is heavy enough to keep the wire tight: thus kinking of the wire is avoided. The circumference of the drum is 1 fathom, and an indicator *e* is fixed to the axle to indicate the number of revolutions of the drum. A slight correction, due to the thickness of wire on the drum, has therefore only to be applied to the indicated number of turns in order to give the amount of wire paid out, or depth of the sounding in fathoms.

In order to stop the drum immediately on the sinker reaching the bottom, the brake F F is employed: it consists of a friction-cord attached at one end to the framework of the apparatus, and passing over a secondary groove on the circumference of the drum A, the other end being weighted at *g*. By means of this brake the increased pull on the wire due to the amount of it paid out is to be more than counteracted, so that the drum will revolve by a pull on the wire due to something less than the weight of the sinker; for, in this case, when the sinker is supported by the bottom there will be a friction on the drum bringing it to rest. The weights *g* have, therefore, to be applied gradually, as the wire runs out. The rule adopted in practice is to apply resistance always exceeding by 10 lbs. the weight of the wire out. Then, the sinker being 34 lbs., we have 24 lbs. weight left for the moving force: that is found amply sufficient to give a very rapid descent—a descent so rapid that in the course of half an hour or fifty minutes the bottom will be reached at a depth of 2000 or 3000 fathoms. The person in charge watches a counter (the indicator *e*), and for every 250 fathoms (that is, every 250 turns of the wheel) he adds such weight to

the brake-cord as shall add 3 lbs. to the force with which the sounding-wheel resists the egress of the wire. That makes 12 lbs. added to the brake resistance for every 1000 fathoms of wire run out. The weight of every 1000 fathoms of wire in air is $14\frac{1}{2}$ lbs. In water, therefore, the weight is about 12 lbs.; so that if the weight is added at the rate indicated, the rule will be fulfilled. So it is arranged that when the 34 lbs. weight reaches the bottom, instead of there being a pull, or a moving force of 24 lbs. on the wire tending to draw it through the water, there will suddenly come to be a resistance of 10 lbs. against the motion. A turn or two and the drum comes to rest. The instantaneous perception of the bottom, even at so great a depth as 4000 fathoms, when this rule is followed, is very remarkable, and has been particularly noticed by Commander Belknap in reports of his soundings influence on the wire as it is being hauled in, and prevents much manœuvring of the ship. For hauling in, the handles of the drum are again shipped, as also two handles on the pulley K, and one man working briskly on each handle the wire is soon got in. When the ship is lifting with a heavy sea there are times when a very great stress is imposed on the wire, and it would be dangerous to haul in too fast. But by an arrangement of Prof. Fleeming Jenkin the hauling in can go on as fast as may be without any danger of overstressing. After some hundred fathoms of the wire have been got in, the ship may start slowly ahead,—an important advantage to a telegraph ship while paying out cable, or to a mail steamer making port.

The tube in the end of the sinker, if fitted with a valve door, brings up a specimen of the bottom. In the commoner sinkers there is merely a cavity which is "armed"



in the Pacific, presented to the United States Navy Department.

The sounding apparatus is best fixed so as to project beyond the bow or stern taffrail. In order to take a sounding the drum A is run out to the end of the rails H H, where it admits of the sinker dropping sheer into the sea. The sinker is then gently lowered by turning the handles of the drum until it touches the water, when the indicator is set at zero. Everything being ready and the ship at rest, the handles of the drum are then unshipped, the check-pawl of the drum is unlocked, and the wire runs rapidly out. Two seamen and a quartermaster are enough. The quartermaster directs the others, sets and reads the indicator, and now, as the wire runs out, applies the weights to the brake. When bottom is reached the indicator is read off, and the hauling up is set about at once. The wire is first supported from the framework by a yarn stopper, or is held by a couple of men with canvas or leather protection for their hands. The drum is then run inboard again, and the wire is led over $\frac{1}{4}$ circumference of the castor pulley I, then passed over the auxiliary hauling-in pulley K, so as to make $\frac{3}{4}$ or $1\frac{3}{4}$ turns before it is coiled on the drum. The use of the castor pulley I is to angle itself with the wire which will, in currents, generally stream out to one side or other. It thus exerts a guiding

with tallow, or a mixture of tallow and soap, to which grains of the bottom adhere. In depths of 4000 or 5000 fathoms, where a sinker of say 100 lbs. would be required, it would become necessary to sacrifice alike the sinker and the specimen. As the wire comes in it may be partially dried by rubbing it with a piece of canvas; and as it is being coiled on the drum, to preserve it from rusting, it is drenched occasionally with oil. When not in use the drum is kept in a bath of oil. It was formerly the custom to apply a solution of caustic soda in the same way, but the oil has superseded it.

The method of making flying soundings with wire is thus described by Sir William Thomson:—"In the first *Hooper* expedition from Pernambuco to Para, the Brazilian Government sent a gun-boat with us to take soundings, but the coal would not carry her the whole way, and we were left to our own resources for soundings during the laying of the cable. The whole route had been sounded over previously by the Brazilian Telegraph Company, so as to form a general idea of the line to be taken by the cable; but still it was very important that soundings should be taken accurately. Accordingly Capt. Headingley arranged that the wire wheel should be set up over the stern of the *Hooper*, and soundings were taken every two hours without stopping the ship. A 30-lb. weight was

hung on a couple of fathoms of cord, but a greater length would have been better. I believe that 5 fathoms ought to have been used. Then the wheel was simply let go with a resistance of about 8 lbs., or, perhaps, an actual resistance of not more than 6 lbs. on the circumference of the wheel. When the ship was running at the rate of 4½ knots an hour, the cable was paying out at the rate of 6 knots; and after, perhaps, 150 fathoms had run out—in some cases 175 fathoms—suddenly the wheel would get so much slower that it almost stopped. In half a turn it was obvious that there was a difference. The moment that difference was perceived, the man standing by laid hold of the rim of the wheel and stopped it. Thus we achieved flying soundings in depths of 150 fathoms with the ship going at the rate of 6 miles; and we obtained information of the greatest possible value with reference to the depth of the water and the course to be followed by the cable. I think this is of such great importance that I never would like to go to lay a cable without an apparatus for flying soundings to be regularly practised, say every two hours at the least."

THE GOVERNMENT TELEGRAPHS.

A REPORT, dated July 17, 1875, of the Committee appointed by the Treasury to investigate the causes of the increased cost of the Telegraph Service since the acquisition of the telegraphs by the State, has just been presented to Parliament. It bears the names of Alfred Austin, H. Weaver, and W. G. Anderson.

The points which received the attention of the Committee were:—

(1). The causes of the very serious discrepancies between the estimates of telegraph expenditure, year after year, and the actual outlay.

(2). The general expenses of the service as compared with those of the telegraph companies.

(a). As to the conduct of the business, and the staff employed for the transmission of messages.

(b). As to the cost of maintenance and extension.

(3). The extent to which offices and services are maintained which are not required by public convenience, and are not paying their expenses.

The following is an abstract of the result of the inquiries into these several points:—

Comparative statement of the expenditure on Telegraph Services, as compared with the grants for the different years since the transfer of the telegraphs to the Post Office, taken from the appropriation accounts rendered by that department to the Comptroller and Auditor-General—

Year.	Grant.	Expenditure.			Surplus.			Deficit.		
(2 months)	£	£	s.	d.	£	s.	d.	£	s.	d.
1869-70.. ..	90,000	62,273	11	5½	27,726	8	6½	—		
1870-71.. ..	360,000	409,493	8	8	—			49,493	8	8
1871-72.. ..	420,000	551,521	11	10¼	—			131,521	11	10¼
1872-73.. ..	669,990	874,945	17	8¾	—			204,955	17	8¾
1873-74.. ..	858,000	967,947	18	2¼	—			109,947	18	2¼

The Post Office asked for a grant of £90,000 for the three months ending March 31, 1870, but the transfer of the telegraphs to the Government having been postponed to January 29, 1870, the grant taken for the expenses of the entire quarter exceeded by £27,726 8s. 6½d. the expenditure of the months of February and March.

It appears from a Parliamentary return of August, 1870, only six months after the date of the transfer, that there were at that time employed in the telegraph branch no less than 4913 clerks, &c., instead of 1528 as proposed, and 3116 messengers, instead of 1283; so that the staff of the telegraph branch as compared with that of the companies is more than doubled. This fact alone will easily account for a great part of the excess of expenditure beyond the grant for 1870-71.

Having examined the accounts of past years, the Committee proceed to consider the expenses of the telegraph branch as compared with those of private companies. The first and most obvious cause has arisen from the fact that the salaries of all the officials of the telegraph companies were very largely raised after their entry into the Government service; it being deemed impossible that the officials of the Telegraph Service should receive lower pay than the officers of the postal service. Another source of considerable expense arises from the fact that instead of a considerable saving being effected by the amalgamation of the working staffs of the different companies into one Government establishment, the staff at present employed for the supervision of the consolidated service in the secretary's office, the engineer-in-chief's office, the divisional engineers' offices, and the account branch is comparatively greatly in excess of that considered necessary under the divided management of the telegraph companies. A further expense has been the necessity on the transfer of the telegraphs to the Government, to dispense with the services of a certain number of the linemen employed by the companies, who were entitled under the Telegraph Act to receive compensation, and who have continued to work on the railway lines, so that to obtain efficient workmen the Government have been compelled to pay wages equal to the full rate paid by the railway companies, together with the compensation granted to the discharged linemen.

The Committee hold that it would not be possible for the Government to work at so cheap a rate as the telegraph companies, and they acknowledge the increased facilities for telegraphing which the public has gained by the transfer of the telegraphs to the Post Office, and the amount of arduous labour by which these results have been obtained. At the same time they are much struck by the very high percentage of the working expenses of the Telegraph Service as compared with the gross receipts, the proportion of working expenses to income having been—

For the 14 months to March 31, 1871 ..	More than 57 per cent.
In 1871-2	Nearly 78¾ „
„ 1872-3	„ 89½ „
„ 1873-4	„ 91½ „
„ 1874-5	More than 96⅔ „

In the case of the telegraph companies, before the transfer, the average cost of working as compared with the gross receipts was about 60 per cent. An amended general estimate of the telegraph revenue and expenditure for the current financial year is submitted, in which the Committee have endeavoured to show the probable deficiency of revenue to meet the expenditure of the Telegraph Service, including interest of the capital raised for the purchase of the telegraph undertakings. This deficiency is irrespective of any provision for a sinking fund to redeem the debt of £9,790,198 in Three per Cent Annuities, which will be increased by the sums awarded to railway companies as compensation under the Telegraph Act of 1868. The charge for the salaries of the staff employed in the Comptroller and Auditor-General's department for the re-examination of the telegraph accounts, is omitted as not being strictly chargeable against telegraph revenue, the accounts being fully examined in the Post Office before they are transmitted to that officer, under the provisions of the Exchequer and Audit Act.

EXPENDITURE.

	£
(1). Telegraph expenditure for the year, as shown in the Post Office estimates submitted to the House of Commons (see page 583, Civil Service Estimates, 1875-6)	1,097,714

(2). Works, included in estimate for public buildings (see Civil Service estimates, same page)	39,466
(3). Stationery, included in Stationary Office estimates (see Civil Service estimates, 1875-6, Class 2, Vote 23, p. 124)	45,000
(4). Estimated charge for postage on account of Telegraph Service, not paid to Post Office revenue	7,000
(5). Estimated charge for manufacture of Post Office telegraph stamps, included in Inland Revenue estimates	2,000
(6). Interest of capital raised (£9,790,198 Three per Cent Stock) for the purchase of the telegraph undertakings	293,706
	£1,484,886

N.B.—This estimate of expenditure does not include any charge for the occupation, by the telegraph branch, of a large portion of the new buildings in St. Martin's-le-Grand, the site and erection of which cost more than £500,000.

REVENUE.

	£
Postal telegraph revenue, as estimated in the Chancellor of the Exchequer's financial statement for 1875-6	1,200,000
Extra receipts, as shown at page 583 of Civil Service estimates for 1875-6	11,200
Estimated value of telegraph services performed for other public departments, not paid to telegraph revenue	4,862
Ditto on account of the Post Office service, not paid to telegraph revenue	300
	£1,216,362
Estimated deficiency of revenue, to cover current expenditure and interest, per contra	268,524
	£1,484,886

The Committee consider that the working expenses could be kept within 70 or 75 per cent of the gross revenue, and that the responsible officers of the Post Office Telegraph Service should be urged to work up to that standard; such a result would cover the cost of working, and the sum necessary for payment of the interest on the debt incurred in the purchase of the telegraphs.

The following return of the number of offices not paying their working expenses was supplied by the Post Office:—

	In London.	In the rest of England and Wales.	In Scotland.	In Ireland.	Total.
1872 ..	10	417	40	261	728
1874 ..	7	303	28	111	449

Out of a total number of 3444 in 1872, and 3692 in 1874. Thus there are between 400 and 500 telegraph offices which do not pay their working expenses, irrespective of the sum required for the maintenance of the wires, the cost of which it is difficult to ascertain. The Committee proceed to say that the closing of such offices can only be done after a careful examination and report by the surveyors and divisional engineers in each individual case, and this they strongly recommend should be undertaken at once by the proper officers of the telegraph branch, and a report of the results prepared in due course. The Post Office are strongly opposed to any general reduction of the system, and they urge, not without reason, that a large sum has already been expended in the erection of lines to these offices, that a further cost would be entailed in the removal of such lines, that the above table shows that the telegraph offices which are an expense to the public are gradually decreasing in number, and that the closing of an office which does little business would in most cases be attended with great discontent and agitation on the part of those who never use it. The Committee fear that the full cost of working these numerous and unremunerative offices is not realised. In London alone there are 373 Postal Telegraph Offices, many of them at very short distances apart. The staff and expenses of this multiplication of offices is, of course, very great *per se*, but if considered in connection with the larger number of clerks required at the central station and at the district centres to receive messages from these numerous branch offices, the expenses incurred, which might be saved by closing such offices, assume far larger dimensions than appear at first sight.

Special attention is called to the maintenance of a double staff of officers on the same ground, viz., the postal surveyors and their clerks, and the divisional engineers and their assistants. It appears to be a matter for the consideration of the Postmaster-General whether, as vacancies occur among the postal surveyors and their clerks, it might not be possible to select men qualified to supervise the engineering work of the district, who would at the same time perform the duties now within the province of the surveyors, which require tact and judgment rather than technical knowledge, thus placing the service under the immediate control of skilled technical officers, who now have no direct voice in the management. To ensure efficiency and economy in working the Telegraph System, it should be thoroughly identified and amalgamated with the Postal Service, as much in fact as in name, and in any re-organisation intended to economise the aggregate cost of working, the officials of the Postal Service would frequently be obliged to give way to the officers and clerks of the Telegraph Service.

The Committee have been very much struck by the advantages which the system of the employment of Royal Engineers appears to offer. At the request of the War Office, the Eastern District was allotted by the Telegraph Branch to the Royal Engineers, who, under Major Webber, have the entire management of the maintenance of the system in that district, and who have also been extensively employed in the construction of new works. The total pay and allowances of the Royal Engineers employed under the Post Office are calculated so as to be about equal to the salaries of the civilians employed in the same positions in other districts, so that the Telegraph Branch saves that part of the pay which is provided in the War Office estimates. The Post Office gains other advantages by the employment of the Royal Engineers:—

(1). They are entitled to no pension from that Department.

(2). Men in any degree inefficient or unsuited for the service can be removed, whereas civilians must be retained until their inefficiency or misconduct are such as to justify their dismissal.

(3). Men not required can at any time be sent back to barracks, and recalled for any press of work.

(4). The Royal Engineers being under military discipline, there is no possibility of a strike.

These advantages, coupled with the desirability, so strongly urged by the War Office, of obtaining a certain number of soldiers trained to telegraph work in the event of war, would, in the opinion of the Committee, render a more extensive employment of the Royal Engineers a measure greatly conducive to the public interest.

Finding it cheaper to erect telegraphs on roads and maintain them with their own staff, than to place them on railways at the prices demanded, the Postal Telegraph authorities have extensively added to the road system transferred to the Post Office under the Act of 1868, and it now becomes a question worthy of their consideration, whether arrangements could not be made with railway companies for the maintenance and renewal by the latter of all lines of telegraph on roads running parallel with, and adjacent to, their railways, such as loop lines from wires on railways into towns, at short distances from the railway, at rates less than those fixed under agreements provided for under clause 9. If the railway companies were

willing to undertake the work at reasonable rates, a great saving must follow.

The special attention of their Lordships is also directed to the fact that, although the number of inland messages has increased from 6,000,000 to 20,000,000, the working expenses having increased in a still greater ratio, the Telegraph Branch is not in the position of the Postal Department, after the introduction of the penny postage. In that case it was evident that an increase of business must eventually lead to a surplus of income over expenditure; but a comparison of the receipts and working expenses of the Telegraph Service, since its transfer to the State, shows that a very large increase of business has been accompanied by a still greater increase of the cost of working and maintenance. The increasing number of messages transmitted, and the falling off of the net receipts, from the commencement to the 31st of March last, are shown in the following table:—

Year ended—		No. of Messages.	Surplus of Income over Working Expenses. £	s.	d.
March 31, 1871	..	9,850,177	303,456	13	5
" 1872	..	12,473,796	159,834	12	8½
" 1873	..	15,535,780	103,120	2	8¾
" 1874	..	17,821,530	90,033	6	11¾
" 1875	..	19,253,120	36,725	0	0

The conclusion is, that, unless some check is put on the expenditure, or some means devised for augmenting the receipts, the management of the telegraphs will become a permanent charge on the finances of the country.

The tariff fixed for the transmission of messages by the Telegraph Act of 1868 was one shilling for the first twenty words; but the actual number of words contained in every message for which one shilling is paid averages forty-three, the additional words in excess of twenty being made up of the words contained in the names and addresses of senders and receivers, which are not charged for, and the words sent with each message which compose the service instructions stated to be necessary for proper departmental control.

After allowing for a sufficient number of words to be forwarded with each message as service instructions, it has been found that nearly 50 per cent of the capacity of the Postal Telegraph wires is occupied in transmitting matter for which no money consideration of any kind is paid, so that, when the present plant has been worked up to its maximum carrying capacity, new plant will have to be provided at a large outlay, in order to duplicate lines, which are only filled to half their capacity with paid messages.

The press tariff charged in accordance with section 16 of the Telegraph Act of 1868 is another fruitful source of loss. One shilling is charged for every hundred words transmitted during the night, and the same sum for every seventy-five words transmitted during the day, twopence only in addition being charged for the same matter forwarded to different addresses.

The Committee endorse Mr. Weaver's opinion that the principle of the stipulations of the tariff authorised by the Telegraph Act of 1868, both as regards messages transmitted for the public and those forwarded for the press, is essentially unsound, and has been the main cause of the large percentage of expenditure upon the Postal Telegraph Service, as compared with the gross revenue collected for telegrams. The introduction of the universal shilling rate should have been accompanied by a withdrawal, in accordance with the system generally prevailing on the Continent, of all free words up to that time allowed for addresses.

The Committee recognise the difficulties which the Post Office would now have to encounter in withdrawing, without offering some equivalent, the privilege of free words allowed in addresses; but some such step is absolutely necessary, as the economies attainable in the expenditure under the present system would not be sufficient to make the revenue exceed the expenditure.

A tariff might be introduced in which, while the minimum price now paid for telegrams, *i.e.*, one shilling, might be lowered, the stipulations of the tariff might be so changed as to turn loss into profit. This purpose might be effected, either by the introduction of a tariff at the rate of sixpence for ten words, inclusive of addresses, or by the adoption of the "word system of charging messages." A charge of one penny per word, including addresses, might be made to commence with, to be reduced to one halfpenny when the system became profitable. The system has been introduced with great success on the Atlantic cables, and is most popular with the public; the principle has been adopted by a majority of twelve to five of the members of the Telegraph Conference at St. Petersburg for all Extra-European lines. Either of the above-mentioned tariffs would, in the opinion of Mr. Weaver, be profitable, because the principle involved in them is commercially sound, the wires would be cleared of *unpaid* work to the extent of nearly half their carrying capacity, and room would thus be made for the increase of traffic to be expected, consequent upon a decrease of price, without any extension of plant or augmentation of working charges. A concession to the press upon these rates would, of course, have to be made; but, if it were seen that Government were determined to carry a measure through Parliament which would reasonably amend the present system of tariff, an arrangement with the press upon far less onerous terms than the present would not be difficult.

The Committee close their Report by reminding their lordships that the transfer of the telegraphs to the State was an experiment of a nature hitherto unknown in this country, that the Telegraph Act of 1868 was passed before the Government had gained any experience of a branch of the public service yet to be created, and that neither Parliament nor the public can have any right to complain if an attempt be made to remedy the defects which are the result of the experimental legislation of past years.

NOTES.

Prof. Hughes's printing telegraph apparatus has just been adopted by the Spanish Administration. This system was first adopted by the American Telegraph Company in 1855, being followed in 1861 by France; in 1862 by Italy and England; in 1865 by Russia; in 1866 by Prussia, in 1867 by Austria, Hungary, and Turkey; in 1868 by Holland: in 1869 by Bavaria and Würtemburg; in 1870 by Switzerland and Belgium; in 1871 by Peru; in 1872 by Buenos Ayres; in 1873 by the Submarine Telegraph Co.; in 1874 by the Argentine Confederation; and in 1875 by Spain. The inventor, Edward David Hughes, was born in 1831, at Louisville, Kentucky. From a boy he devoted himself to physico-mathematical and mechanical studies. At the age of 19 he became Professor of Physical Science in the College of Kentucky, and the same year (1850) he began his studies on the type-printer, the perfecting of which cost him twenty years of study and experiment.

Referring to the delay in the completion of the Direct United States Cable, the *World* says—"The *Faraday* went out in April to complete the laying of the cable. It started somewhat too early, but when the ice cleared away it laid its cable, and messages were transmitted between New York and the office in London at a speed of about twelve words per minute. There was, however, a trifling defect in the insulation about 250 miles from Newfoundland. A like defect exists in the French cable of the Anglo Company, and is rather a theoretical than a prac-

tical fault, for it does not interfere with the transmission of messages, and, curiously enough, rather increases the speed of transmission. The *Faraday* was, however, ordered on her return voyage to cut out this defect. She therefore broke the cable in two places, and separated about 35 miles from each other. On breaking the Irish end, last Saturday week, she called attention to the fact that she had only 50 miles of surplus cable on board, and that whilst 50 miles ought to be enough, even with slack, to lay 35 miles, yet that it might perhaps be safer to have more. The Company had about 70 more miles in London; and after some discussion between the ship and the office, through the cable, it was determined that she should return to England to take in these 70 miles. She will at once start again to the gap. Her business will be to take up the Irish end, to splice it to the cable on board, to run out 35 miles of cable, and then to effect the final splice to the American end in shallow water. There is no reasonable doubt, therefore, that the cable of the Company will be opened for public traffic in a few weeks."

A small fresh-water fish, belonging to the family of Siluroids, and remarkable for possessing an electric organ like the *Gymnotus*, or electric eel, has been recently added to the collection of the Zoological Society.

The Royal Commission on Scientific Instruction and the Advancement of Science have now held their final sitting, and appended their signatures to the final Reports.

By means of the Wheatstone automatic system between 30,000 and 40,000 words were transmitted during the trial of Colonel Baker, at Croydon, on Monday last.

A telegram, dated August 1st, from Vienna, announces that—in compliance with the resolutions passed by the St. Petersburg International Telegraph Conference—cipher despatches, whether inland or outward, are now received and transmitted by all Austro-Hungarian telegraph offices.

The Western Union Telegraph Co. is completing a tower of 50 feet in height on the crest of the lofty highlands of Neversink. The operators, who are to have the most powerful glasses, will be able to distinguish steamers and other vessels 20 miles out.

At Simla a house belonging to the Government, and inhabited by one of the leading officials, was recently struck by lightning. A native subordinate of the Public Works Department was deputed to erect a conductor. In course of time, says the *Times of India*, the workman placed four metallic rods in position on the roof, and continued them about half way down the building itself, when, material failing him, he deserted his job!

CORRESPONDENCE.

TELEGRAPHING BY FLASHES OF LIGHT.

To the Editor of the Electrical News.

Sir,—I have lately been told by a friend that Mr. H. C. Mance, of the Indo-European Telegraph Department, claimed the invention of a system of telegraphing by flashes of light, called the *heliograph*.

I have also read, in the *Telegrapher* of July 17, 1875, a letter of Mr. F. L. Pope claiming the invention for America, where a *heliotrope* has been used for twelve or fifteen years by the United States Engineer officers engaged in the survey of the great lakes.

It may well be said in this case that there is nothing new under the sun, as neither Mr. Mance nor the American Engineers can claim the merit of an invention described twenty years ago at full length in the *Annales Télégraphiques* (October, 1855, 4e. and 5e. livraisons; Paris: Lacroix Baudry). M. Leseurre, Directeur de Station, calls his invention *héliographe*, and gives, in his "Mémoire sur l'Emploi des Rayons Solaires pour la Transmission des Signaux à des Distances Quelconques," a full description of the apparatus applied to his system as experimented in the south of Algeria.

It would, therefore, appear that *even the name* of the instrument claimed by Mr. Mance as an invention belongs already to some one else, and although M. Leseurre, who is now dead, will not rise to claim priority, it may be interesting for your readers to be enlightened on the real facts.—I am, &c.,

T.

NOTICES OF BOOKS.

Manual of the Natural History, Geology, and Physics of Greenland and the Neighbouring Regions. Prepared for the use of the Arctic Expedition of 1875 under the Direction of the Arctic Committee of the Royal Society, and Edited by Professor T. Rupert Jones, F.R.S., F.G.S., &c. Together with Instructions Suggested by the Arctic Committee of the Royal Society for the use of the Expedition. Published by Authority of the Lords Commissioners of the Admiralty. 1875.

The brave men comprising the Expedition recently despatched to explore the coast of Greenland, and to reach, if possible, the North Pole, started under more favourable auspices than former expeditions have done, inasmuch as they are provided with a trustworthy account of all the scientific results obtained by previous explorers, and also with instructions for future observations.

The Committee of the Royal Society divided the branches of science which were to be represented among several Sub-Committees. The several portions into which the instructions are divided appear with the names of those by whom they were individually drawn up, and who—after consultation with their colleagues—are held responsible for their final form. Thus the name of Sir William Thomson is attached to the instructions relating to the observations on Atmospheric Electricity; that of Prof. G. G. Stokes to a note on Auroral Observations, to Spectroscopic Observations, and also to Pendulum Observations; Prof. J. C. Adams and Captain Evans are responsible for the paper on Determination of Elements and Use of Magnetical Instruments; Mr. R. H. Scott for the Meteorological Instructions; Mr. J. R. Hind for Astronomical Data; while instructions connected with other branches of science have been drawn up by Professors Huxley, Haughton, Roscoe, and Tyndall; Dr. Hooker, Mr. W. Spottiswoode, and Mr. Lockyer.

The instrument to be used for the observation of Atmospheric Electricity is Sir William Thomson's portable electrometer. The concise and valuable directions for keeping the instrument in order, and using it to make observations, will be of value to our readers generally. They are summarised in the following short practical rules:—

I. The instrument having been received from the maker with the inner surface of the glass and all the metallic surfaces within clean and free from dust or fibres, and the pumice dry. *To prepare it for use*:—

(1.) Remove from the top the cover carrying the pumice. Drop upon the pumice a small quantity of the prepared sulphuric acid supplied with the instrument, distributing it as well as may be over the whole surface of the stone. There ought not to be so much acid as to show almost any visible appearance of moisture when once it has soaked into the pumice. Replace the cover without delay, and screw it firmly in its proper position, and then leave the instrument for half-an-hour or an hour, or any longer time that may be convenient, to allow the inner surface of the glass to be well dried through the drying effect of the acidulated pumice on the air within.

(2.) Turn the micrometer screw till the reading is 2000. (There are 100 divisions on the circle which turns with the screw on the top outside, and the numbers on the vertical scale inside show full turns of the screw. Thus each division on the vertical scale inside corresponds to 100 divisions on the circle; and 20 on the vertical scale is read "2000.") Introduce the charging rod, and give a charge of negative electricity by means of the small electrophorus which accompanies the instrument. When enough has been given to bring the hair a little below the middle of the space between the black dots, give no more charge, but remove the charging rod, and close the aperture immediately. If now the hair is still seen a little below the middle of the space between the black dots, turn the screw-head in such a direction as to raise the attracting disc, and so diminish the attraction till the hair is exactly midway between the dots. Watch the instrument for a few minutes, and if the hair is seen to rise, as it generally will (because of the electricity which has been given, spreading over the inner surface of the glass), turn the micrometer-screw in the direction to lower the attracting plate, so as to keep the hair midway between the dots.

(3.) The insulation will generally improve for several hours, and sometimes for several days, after the instrument is first charged. The instrument may be considered to be in a satisfactory state if the earth reading does not diminish by more than 30 divisions per twenty-four hours. If the maker has been fortunate with respect to the quality of the substance of the glass jar, the earth reading may not sink by more than 30 divisions per week, when the pumice is sufficiently moistened with strong and pure sulphuric acid. Re-charge with negative electricity occasionally, so as to keep the earth reading between 1000 and 2000.

II. *To Keep the Instrument in Order.*—

Watch the pumice carefully, looking at it every day. If it begins to look moist, remove the cover, take out the screws holding the lead cup, remove the pumice and dry it on a shovel over the galley fire. When cool put prepared sulphuric acid on it, replace it in the instrument, and re-electrify according to No. I.

Never leave the pumice unwatched in the instrument for as long as a week. When the instrument is to be out of use for a week or longer, take the pumice out of it.

III. *To Use the Portable Electrometer for Observing Atmospheric Electricity.*—

(1). The place of observation, if on board ship, must be as far removed from spars and rigging as possible. In a sailing ship or rigged steamer the best position for the electrometer generally is over the weather quarter when under way, or anywhere a few feet above the tafferel when at anchor. On shore or on the ice a position not less than 20 yards from any prominent object (such as a hut or a rock or mass of ice or ship) standing up to any considerable height above the general level, should be chosen. Whether on board ship, or in an open boat, or on shore, or on the ice, the electrometer may be held by the observer in his left hand while he is making an observation; but a fixed stand, when conveniently to be had, is to be preferred, unless in the case of making observations from an open boat.

(2). To make an observation in ordinary circumstances the observer stands upright, and holds or places the electrometer in a position about 5 feet above the ground (or place on which he stands) so as to bring the hair and two black dots about level with his eye. The umbrella of the principal electrode being *down* to begin with (and so keeping metallic connection between the principal electrode and the metallic case of the instrument) the observer commences by taking an "earth reading." The steel wire, with a match stuck on its point, being in position on the principal electrode, the match is then lighted, the umbrella lifted, and the micrometer screw turned so as to keep the hair in the middle between the black dots. After the umbrella has been up and the match lighted for 20 seconds or half a minute, a reading may be taken and recorded, called an "air reading." A single such reading constitutes a valuable observation. But a series of readings taken at intervals of a quarter of a minute or half a minute, or at moments of maximum or minimum electrification during the course of two or three minutes, the match burning all the time, is preferable. In conclusion, remove the match if it is not all burned away, lower the umbrella home, and take an earth reading.

(3). The electric potential of the air at the point of the burning match is found by subtracting the earth reading from the air reading at any instant. When the air reading is less than the earth reading the air potential is negative, and is to be recorded as the difference between the earth reading and the air reading with the sign - prefixed. The earth reading may be generally taken as the mean between the initial and final earth readings. But the actual earth readings and air readings ought all to be recorded carefully, and the full record kept.

(4.) Note and record the wind at the time of each observation, also the character of the weather.

IV.—*Observations to be made:*—

(1.) At the commencement of the Expedition, in the course of the northward voyage, observations of atmospheric electricity ought to be taken regularly three or four times a day; also occasionally during the night, to give the observer some practice in the use of a lantern for reading the divisions on the circle and of the vertical scale.

(2.) When stationary in winter quarters, observations should be made three times a day, at intervals of six hours; for example, at 8 a.m., 2 p.m., and 8 p.m.; or at 7.30 a.m., 1.30 p.m., and 7.30 p.m. Whatever times are most convenient may be chosen, provided they be separated by intervals of six hours.

(3.) It is very desirable that hourly observations should be made, if only for a few days, in winter and in summer. If possible, arrangements to do so at least for six consecutive days in winter, and for six consecutive days in summer, should be made. The results will be very interesting, as showing whether there is a diurnal or semi-diurnal period in either the Arctic winter or summer, as we know there is at every time of year in places outside the Arctic circle.

(4.) Make occasionally special observations when there is anything peculiar in the weather, especially with reference to wind.

V.—*Special Precautions:*—

(1.) In the Arctic climate more care may be necessary than in ordinary climates as to earth-connections. Therefore put a piece of metal on the stand on which the electrometer is placed during an observation on board ship, and keep this in metallic communication with the ship's coppers or lightning-conductors. If the electrometer is held in the hand, with or without a glove, a fine wire ought to be tied round the brass projection which carries the lens, or otherwise attached to the outer case of the electrometer, and by this wire sufficient connection maintained with the earth during an observation. The connection will probably be sufficient if a short length of the wire is laid on the ice, and the observer stands on it. Enough, however, is not yet known as to electric conductivity of ice; and to make sure, it may be necessary to have a wire or chain let down to the water through a

hole in the ice, and metallic connection kept up by a fine wire between this and the electrometer case during an observation.

(2.) The observer's cap (particularly if of fur) and his woollen clothing, and even his hair if not completely covered by his cap, will be apt in the Arctic climate to become electrified by the slightest friction, and so to give false results when the object to be observed is atmospheric electricity. A tin-foil cover for cap and arms, kept in metallic communication by a fine wire with the hand or hands, applied to the case of the electrometer or to the micrometer screw-head, should therefore be used by the observer, unless he has made sure that there is no sensible disturbance from those causes, without the precaution.

VI.—*Instruments, Stores, and Appliances for Observation of Atmospheric Electricity, sent with the Expedition* :—

(1.) Two portable electrometers, Nos. 35 and 36, each with one steel wire, for carrying match, one charging-rod, and one electrophorus, for charging the jar.

(2.) Six spare steel wires (three to go with each instrument).

(3.) Supply of matches ready made. (The slower the match burns the better. If those supplied burn too fast, steep them in water and dry them again.)

(4.) White blotting-paper and nitrate of lead, to make more matches when wanted. (Moisten the paper with a weak solution of nitrate of lead, and roll into matches, with thin paste made with a very little nitrate of lead in the water).

(5.) Six spare pumices (three for each electrometer); india-rubber bands to secure pumice in lead case.

(6.) Eight small stoppered bottles of prepared sulphuric acid (four for each electrometer).

(7.) Tin-foil and fine wire.

In a future number we shall refer at greater length to the account of previous observations on Terrestrial Magnetism, Atmospheric Electricity, and the Aurora Borealis, included in the excellent "Manual" edited by Prof. Rupert Jones, the part relating to Physics being compiled by Prof. W. G. Adams, F.R.S.

ELECTRICAL SCIENCE IN FOREIGN JOURNALS.

(THIS column is devoted to a list of Electrical Memoirs published in Foreign Journals. Those of importance will be either translated in full or given in abstract.)

Dingler's Polytechnisches Journal,
Band 216, Heft 6.

Historical Sketch of the Magneto-Induction Machines, with Uninterrupted Current of Invariable Direction.—Dr. E. Zetzsche.—This paper has been forwarded to us by the author; it will shortly appear in our columns.

Mayes's Caoutchouc Suspension for Compasses.

Subterranean Telegraph Line.—M. Holtzmann.—A line of this kind, forty miles in length, is laid in the neighbourhood of Amsterdam. A cast-iron trough is placed in the bottom of a trench, and filled with an insulating mixture, liquid pitch still in the warm state. The gutta-percha covered wire is then put in the liquid, the trough is closed with a lid, and the trench filled up.

Polytechnisches Central Blatt,
No. 11, 1875.

The Clocks at the Vienna Exhibition.—Dr. Frick.—Some electric arrangements are noticed.

Zinc as a Preventive of Incrustation in Boilers.—M. Protzen recommends placing a piece of zinc in the boiler. A galvanic current is produced, which preserves the iron from oxidation and deterioration, and makes the mineral constituents of the water separate as fine, easily-removed slime, incrustation proper being wholly prevented.

Californian Quicksilver.—M. Ernst.—This gives statistics of recent production.

Annales de Chimie et de Physique,
August, 1875.

Relations Between Electric and Capillary Phenomena.—M. Gabriel Lippmann.—The following is *resumé* (by the author) of this valuable memoir. Two distinct laws have been demonstrated by experiment; the first (chap. i.) connects the capillary constant with the electric difference; the second (chap. ii.) connects the variation of the electric difference with variations of area of the surface. These two laws, established separately by experiment, are connected together by a tie essentially theoretical. It is shown (chap. ii.) rigorously and without hypothesis, that in the experiment of the funnel (there described), which is based on the second law, electric work would be created, if the first law were not assumed. In the mathematical theory of chap. iii. this relation has been established anew, in analytic form; the analysis rests on two principles :—(1), conservation of energy; (2), conservation of quantities of electricity. No hypothesis has been called in, either in this or in the rest of the work; it is to avoid doing so, that I have abstained from giving a physical theory, an explanation of the properties observed. The electro-capillary motor described (chap. iv.) shows directly—(1), that an indefinite quantity of electrical work can be converted into mechanical work by means of capillarity; (2), that the phenomena described above are reversible. If we compare the phenomena with those of thermo-dynamics, we find that the first law answers to the law of dilatation of bodies by heat, and the second to that of cooling during expansion. The first law has received two applications: (1), measurement of the capillary constant—the measurement hitherto has been illusory (chap. v.); (2), measurement of the electro-motive forces. The electrometer described in chap. vi. is much the most precise of the electrometers now known. Chap. vii. contains the explanation of the whirlwinds described by Gerboin. The principle explaining them seems susceptible of some further applications.

The American Journal of Science and Arts,
No. 55, Vol. x., July, 1875.

Results Derived from an Examination of the United States Weather Maps for 1872, 1873, and 1874.—Elias Loomis.—Third paper.

Preliminary Note on a Magnetic Proof Plane.—H. A. Rowland.—About four years ago the author made a large number of experiments on the distribution of magnetism on iron and steel bars, by means of a coil of wire sliding along the bar: the induced current in the coil, as measured by a galvanometer, was a measure of the number of lines of force cut by the coil, and can be found in absolute measure by his method of using the earth conductor. These researches will shortly be published. The method used by the author in these experiments he considers the only correct one for experimenting on magnetic distribution. His purpose in this note is to extend it to bodies of all shapes, so that experiments on magnetic distribution may become as simple and easy to perform as those on electrical distribution. The apparatus required is merely a small coil of wire, ¼ to ⅛ inch in diameter, containing from 10 to 50 turns, and a Thomson galvanometer. To reduce to absolute measure, another coil—about a foot in diameter, and containing 20 or 30 turns—is required. Having attached the small coil, or magnetic proof plane, to the galvanometer, it has merely to be laid on the required spot, and, when everything is ready, to be pulled away suddenly and carried to a distance, and the momentary deflection of the galvanometer needle will be proportional to that component of the lines of force at

that point which is perpendicular to the plane of the coil. And if applied to the surface of a permanent magnet, the so-called surface density of the magnetism at that point will be nearly proportional to the deflection. In the case of an electro-magnet the surface density will be nearly proportional to the deflection, minus the deflection which would be produced by the helix alone, though the last is generally small, and may be neglected. By a coil of this kind the intensity of the magnetic field at any point may be determined, and a complete map made. The largest-sized magnets are to be preferred in obtaining the distribution by this method.

An Application of the Horizontal Pendulum.—Harcourt Amory.—Zollner's paper on the horizontal pendulum suggested the application of the instrument to proving Ampère's laws of the attraction and repulsion of currents. The wire which forms the upper support of the pendulum is connected with one pole of a battery, and is then led along the horizontal bar of the pendulum, best made of glass, and is bent in the form of a parallelogram at the extremity of the bar. The wire is then led back to form the other pole of the battery through a fixed coil of wire placed in the neighbourhood of the end of the pendulum. The current first passes to the upper suspending wire, around the parallelogram at the extremity of the pendulum, through the lower supporting wire, through the outside coil, and returns to the battery. By turning the outside coil upon a horizontal axis, the laws of attraction or repulsion of rectilinear currents can be shown. The apparatus is well adapted to show the action of solenoids upon each other.

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Cert.	Submarine Cables Trust	100	95—99
12	Telegraph Construction	All	23—23½
100	Ditto, 7 per cent Bonds	All	101—104

PATENTS.

GRANTS OF PROVISIONAL PROTECTION FOR SIX MONTHS.

2335. Auguste Conod, watch and clock manufacturer, Lausanne, Swizerland, now of 8, Southampton Buildings, London, for the invention of "Improvements in electric clock apparatus, parts of which are applicable to ordinary clocks."

2405. George Westinghouse, jun., Pittsburg, Pennsylvania, United States of America, at present of 115, Chancery Lane, Middlesex, for the invention of "Improvements in pneumatic brake and intercommunication signalling apparatus for railway trains."

2410. François Marie Alexandre Chauvin, Louis Henri Goizet, and Alfred Aubry, gentlemen, 23, Boulevard de Strasbourg, Paris, for the invention of "An improved electric submerged lamp."

2495. Christian Heinzerling and Henry Liepmann, both of Glasgow, Lanark, North Britain, for the invention of "Improvements in the recovery and utilisation of refuse caoutchouc and gutta-percha."

ABSTRACTS OF SPECIFICATIONS.

Improvements in Grapnels for Raising Submarine Cables.—Walter Claude Johnson, civil engineer, 38, Old Broad Street, London. December 10, 1874.—No. 4253. The object of this invention is to cut the cable and to raise one end only. The shank is similar in form and size to that of a grapnel ordinarily used for recovering cables. At the base of the shank are formed strong deep tapering jaws, preferably two in number; in each of these jaws is placed a hinged clip capable of receiving the bight of the cable, the inner surfaces of which are roughened or grooved so as firmly to grip the interposed cable. A bolt of lead or other suitable material is placed under the clip so as to keep it in the best position for receiving the cable, and a steel spring keeps the sides of the clip pressed firmly against the cheeks of tapering jaws. The prongs are made wide at their base so as to guide the cable into the before mentioned clip. Near one end of this clip is situated a V knife, which is similar in construction to that in ordinary cutting grapnels.

Improvements in the Construction and Working of Railway Signals.—Theodore Sington, Manchester, Lancaster, January 6, 1875.—No. 57. This invention comprises:—First. The construction and the mode of fixing the signal to the signal-post. Secondly. The use of the magnet and armature in conjunction with the signal for working the same. Thirdly. The form and mode of working the signal levers. Fourthly. The mode of interlocking the signal levers with the point levers. Fifthly. The use of the electric current for working the signal. Sixthly. A powerful electric bell intended to be used as a fog bell. Seventhly. An improved mode of arranging the signals and posts arising out of the greater facilities offered by this new agency.

Improvements in Thermo-Electric Apparatus.—Charlton James Wollaston, 8, Park Place, Marylebone, Middlesex, January 6, 1875.—No. 58. This invention relates to apparatus for obtaining electricity in a convenient and economical manner from heat generated from the combustion of fuel.

PATENTS GRANTED IN FOREIGN STATES.

PRUSSIA.

10. R. Gottheil, of Berlin, for "A lamp for electric light."—3 years.—Dated May 25, 1875.

TO CORRESPONDENTS.

*** Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which "The Electrical News and Telegraphic Reporter" is the organ, will always command attention. Literary communications and books for review should be addressed to the Editor; business communications to the Publisher, Boy Court, Ludgate Hill, London, E.C.

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THE ELECTRICAL NEWS

AND

TELEGRAPHIC REPORTER.

EDITED BY WILLIAM CROOKES, F.R.S., &c.

TO ELECTRICIANS EVERYWHERE.

Since the day when Electricity was first discovered, until now, its vast importance and its high destinies have grown upon the human mind. Fresh phases of its power, fresh results, new means of obtaining and governing its action, and multiplied ends to which it may be turned, have constantly discovered themselves; till to-day it stands out as one of the grandest subjects presented to the scientific and practical world for investigation and research. Perhaps, however, no other Science or Art has exhibited so extraordinary a concurrence of anomalies. It is at once the most terrible monster and the most humble and obedient servant, its action is at one moment beneficial, at the next destructive; its range is boundless, yet it may be "cabined, cribbed, confined" at ease; it is everywhere present, while its nature is only imperfectly understood; and, to crown all, although it is one of the most important agents in the action and the phenomena of the universe, and increasing knowledge of its applicability to the needs of our race is of the utmost importance, no direct means of ascertaining the thoughts and discoveries of its students, or of bringing them before the scientific and mechanical community, at present exist. Attempts have been made to supply this want, and journals have been started with the professed object in view of making public all that is known or can be learnt of Electricity in all its branches. But they have degenerated into unscientific records of unimportant events, and the purpose for which they were established has been lost sight of. Thus it comes that—while Engineering, Chemistry, and other Applied Sciences have all their representative recognised organs—the Electrician finds himself without any current journal from which he can learn the events which are daily occurring of peculiar interest to himself.

Such a want has now been supplied by the establishment of the Electrical News and Telegraphic Reporter. In its columns will be found the most valuable opinions of eminent Electricians and scientific men all over the world. Articles will be contributed which will be of value not only to those who study Electricity as amateur experimentalists or scientific inquirers, but also to those whose daily life is bound up with the advancement of practical knowledge in all departments of the science, and who as electricians, telegraphists, electrotypers, electroplaters, and chemists have continually to deal with the same marvellous agent of force in different ways. Nor will the doings of foreign societies be ignored as in times gone by, but, in the shape of carefully prepared abstracts, their proceedings will be presented to our readers. Every opportunity will be given for the healthful discussion of the science in all its branches, and a fair unbiassed course will be steered in all questions of dispute.

This, then, is our Programme in brief. More we could promise, but prefer to let the new periodical speak for itself. The subject with which it will deal is of too great importance to need one word of recommendation. Daily experience teaches us that we are as yet on the threshold only of a vast expanse of electrical knowledge. This has to be explored, and as the research gains in strength and intelligence the results will be far beyond all present conception. The feat of girdling the earth in forty minutes will be eclipsed by great deeds yet to be done, and if the establishment of the Electrical News and Telegraphic Reporter conduces to the hastening of this desirable end our object will have been gained, and we shall be fully rewarded.

Boy Court, Ludgate Hill, London, E.C.
July 1st, 1875.

London: Printed and Published by the Proprietor, William Crookes, at the Office, Boy Court, Ludgate Hill, E.C. August 5, 1875.

THE

ELECTRICAL NEWS

AND

Edited by Wm. Crookes, F.R.S., &c.] **TELEGRAPHIC REPORTER.** [Registered for Transmission Abroad.

Vol. 1.—No. 7.] Thursday, August 12, 1875. [Price, 4d. Post Free, 4½d.

CONTENTS.

THE ELECTRICAL NEWS.

VOL. I. No. 7.

THE GOVERNMENT TELEGRAPHS.

THE Report of the Committee appointed by the Treasury to enquire into the causes of the increased cost of the Telegraph Service since the acquisition of the telegraphs by the State has attracted no small amount of attention. With but few exceptions our contemporaries have taken a somewhat exaggerated view of the subject, for they seem to think that cheap telegraphy is now proved to be an impossibility. Before the next parliamentary session different idea will, we trust, prevail. We believe that profit to the State is more likely to accrue by reducing the charge for inland telegrams than by depriving the public of present advantages. Both the Departmental Committee and the Press attach, we think, undue importance to the fact that the Telegraph Branch is not in the position of the Postal Department after the introduction of the penny postage. We fail altogether to perceive the justice of such a comparison. The transmission of a mere letter surely cannot be compared to the transmission of messages by the Electric Telegraph. If there is any force at all in the argument, it is on the side of those who advocate sixpenny messages and an extension of present advantages; for as the charging only a nominal sum for the postage of letters has led to the Department becoming a source of profit to the State, it would seem to follow that by halving the present charge for messages the telegraph would daily be used by tens of thousands who, even under the present system, are greatly alarmed if a telegraph messenger appears at their door. Great economies can doubtless be effected, but the object of the Government in acquiring possession of the telegraphs was to obtain greater advantages for the public, and during the organisation of the system its financial success has necessarily been a secondary consideration. There is reason to believe that if Mr. Scudamore had not been hindered by monetary difficulties and opposition of every kind a still greater success would have been achieved. Be this as it may, we see no reason for alarm. In another column we give our readers a brief report of the Russian telegraphic system. From this it appears that in Russia the expenditure exceeded the receipts during the first ten years, but from 1857 to 1874 the excess of receipts over expenditure has been well marked and steady. The English telegraphs will eventually yield a like result. Being entirely unconnected with any Government department, and representing no commercial enterprise, our views are unbiassed, and we do not hesitate to say that the consequences of adopting either of the courses proposed by the Committee should be very carefully considered. We look forward to the official statement of the Postmaster-General respecting this report. Meanwhile we may refer our readers to a letter which appeared in the *Times* of the 5th inst. The writer is evidently well informed, and, upon facts and figures which he says are indisputable, he holds that the present rates are amply sufficient, not only to cover all expenses, but to leave a handsome surplus. He argues, and not without reason, that it would be as fair to compare the cost per man in the British Army with the cost per man in the Army of Ashantee, for the purpose of discrediting the Secretary of War, as to compare the present system of Inland Telegraphy with that in vogue under the old companies, for the purpose of discrediting the Postal Telegraph authorities; and then he refers to the increase in the number of offices, of miles of line and of wire, &c.,* thus showing that the two periods which mark these changes can only be comparable for the sake of contrast. The writer proceeds:—

"The Committee very wisely suggest that a large saving may be effected by curtailing the present system of 'signalling' messages. . . . Now, it was within the knowledge of the Committee, although they do not say so, that it has been within the intention of Mr. Scudamore, almost from the date of the transfer, to curtail the system of 'signalling.' It was seen, as clearly as the Committee see, that it nearly doubled the work of the clerks and the wires. If it could only be got rid of altogether the saving effected would be enormous; if it could only be reduced to one-half, or by one-third, or even a fourth, a heavy load of expenditure would be at once lifted out of the Department. The system, however, was inherited from the old companies, together with the clerks who were used to it, and it was rightly felt that to make any sudden change before matters got into thorough working order would be to endanger the public service both as regarded speed and accuracy. A new system, several alternative systems, indeed, were prepared as long ago as 1871, and are ready for adoption at any time the authorities may think safe for bringing them into operation. Here, then, is opened a wide area for reduction of expenditure. Any system that will relieve the wires and the clerks of an eighth of the work they at present have to perform will thrust the pruning-knife into the most luxuriant branches of telegraphic expenditure.

"With what appears to be an original suggestion of the Committee—namely, the closing of telegraph offices at present unremunerative—the public will scarcely agree. Independently of the fact that such offices have, for the most part, been opened under public pressure, it is to be remembered that the principal outlay involved in their establishment has been already incurred. It is further to be remembered that such offices, though unremunerative at first, very soon become remunerative. For instance, in the year 1872, out of a total of 3444 offices in Great Britain, 728 were unremunerative. In 1874, out of a total of 3692 offices, the numbers of those which were not remunerative have sunk to 449. Here again, therefore, if experience is to be our guide, we have a better prospect of increasing revenue by keeping the unremunerative offices open than we have of decreasing expenditure by closing them.

"The Committee suggest that a considerable saving might be effected by the employment of the Royal Engineers in the construction and repair of telegraph lines instead of ordinary workmen. At the urgent request of the War Office the Royal Engineers have been employed for some time in what is known as the Eastern Division always, however, under a protest from the Head of the Telegraphic Department. In the North-Eastern and North-Western Divisions the work has been done by ordinary workmen. What has been the result? That in the Eastern Division, where the Royal Engineers were employed, the average cost of labour per mile of wire

* ELECTRICAL NEWS, vol. i., No. 5, p. 56.

comes out as £1 19s. 0½d., while in the North-Western it comes out as £1 11s. 11½d., and in the North-Eastern, £1 6s. 5d. Seeing that the mileage of wire dealt with in the North-Eastern and North-Western districts exceeded 20,000 miles, the loss which would have accrued had the Royal Engineers been employed everywhere, would have been a serious one. Instead, therefore, of recommending the employment of the Royal Engineers, the facts would seem to point to their dismissal—if the object be, as it ought to be, harmless reduction of expenditure. . . . There is no need to increase telegraph rates to make the Department a paying concern. What it wants in the first place is more capital. The sum voted for the purchase of the goodwill and plant of the old companies was no doubt a large one. The sum or sums provided for the enormous extension which has occurred have been miserably inadequate. The consequence has been that the Department has had to lead a kind of from hand to mouth existence, grabbing any stray capital it could lay hold of, and stopping up holes here and holes there with dabs taken at random out of revenue. . . . Hitherto, the Department has been loaded with all the first charges of a new and rapidly extending concern. As time goes on, these extra outlays will fall off, while the income will steadily increase. . . . As matters stand at present the addresses on a shilling message average twelve words, while the message itself averages seventeen words, so that on the average twenty-nine words are now sent for 1s. The Committee propose either to charge 6d. for every ten words, and to charge for the address as well as for the message, or to charge 1d. per word for address and message, or to charge 3d. per message, plus ½d. per word for address and message. Under the first scheme the public would have to pay 1s. 6d. for that which now costs them 1s.; under the second, 2s. 5d. for that which now costs them 1s.; and under the third, 1s. 5½d. for that which now costs them 1s."

While it is the duty of the Treasury to endeavour to make each department of the State a source of profit, it must not be forgotten that the extension of the telegraphic system has been attended with immense advantages, so that indirectly it has been profitable. A return to anything like the old system of charges would be a far greater calamity than the temporary loss of interest on money expended in purchasing the telegraphs, inasmuch as the commercial prosperity of the country would, by the adoption of such a retrograde step, be greatly impeded.

ON INDUCTION CURRENTS PRODUCED IN TELEGRAPH WIRES.

By M. LAGARDE.
Inspector of Telegraph Lines.

For a very long time induction phenomena have been known to physicists who have, however, only studied them in their laboratories. The difference between their circuits and those of telegraph lines is so great that it is only of late years it has been convincingly ascertained that a current sent on one aërial wire will induce a current in the other when they are near each other for a sufficient extent. Morse, and other machines of that class, were unaffected by these induced charges, hence the belief in their non-existence on telegraph conductors. When, however, Hughes's apparatus came into use, it was noticed in some places that it was not always possible to work at the same time through two neighbouring wires with his apparatus, whilst no obstruction was offered to the use of the Morse on the very same lines. For a long time it was thought this was owing to leakages between the two wires; but it is now recognised that induction is the sole cause. I have undertaken, since 1869, numerous experiments on this subject, and though the results are incomplete, and show scarcely more than the truth of the fact without indicating its law, I put them forth to the world in the hope of completing theoretic conclusions when other facts shall be revealed to me by future experiments. When a derivation exists between two lines, and when a current is sent on one of them, if on the other there is a polarised electro-magnet receiver—such as Hughes—it will work if the derived current is strong enough, and if it is of a suitable direction in the coils of the electro-magnet. The same thing takes place when the two wires starting from the same post are perfectly insulated on the line, but the earth at the post is defective (too resisting): then only one portion of the current flows to earth, the other betakes itself to the second wire absolutely as if they crossed at the two points where the two conductors unite with earth. But when the two wires are parallel and near for a great length, and there is an induction by one upon the other—every time we work by one of them, each emission of current gives rise to two induced currents—one on closing and another on opening circuit. If these currents are strong enough, one of them will necessarily work the polarised electro-magnet. By joining the line wire successively to each of the extremities of the electro-magnet's wire, the apparatus will always act so long as transmission is effected by the neighbouring wire; on the contrary, there is only one extremity of the wire of the coils which can be joined to line so as to work the apparatus from a derivation current (or leak) between the two wires. We have thus, with an apparatus of this kind, a certain means of ascertaining whether, when the transmission sent on one of them affects the other, the influence is due to induction or derivation currents. The experiment, which consists in insulating the two wires at the opposite end, in sending a current upon one of them, and then observing a galvanometer placed in the other's circuit, is insufficient, because it does not give any indication relative to the derivations proceeding from a common bad earth.

In nearly all my experiments I made use of Hughes's instrument, an instrument which a suitable regulation will render very sensitive: the remainder of my experiments were made with other polarised electro-magnet instruments. Very sensitive galvanometers, whose deflection is almost instantaneous, such as Thomson's mirror galvanometer, may be serviceable for these studies in certain cases, but not always.

The first experiments were undertaken in 1869 on the underground line from Paris to Juvisy, at the time when it had just been constructed, and before it was connected with the aërial conductors. The cables of this line are 23 to 24 kilometres long, and the two smallest adjacent and parallel conductors are 8 millimetres from axis to axis. I first took the induced wire, and the inducing wire, in the same cable and contiguous one to the other, and I placed upon each of them at the Paris end one of Hughes's apparatus.

I considered separately the case when the two wires were to earth through large resistances.

In the first case when signalling on No. 1 wire, with a battery of 80 Daniell elements, the signal was recorded by the apparatus attached to the No. 2 wire, whichever end of the exciting coil was in communication with the line: the cause was therefore an induction one. When the battery was of 150 elements, the *induced* current represented the value of a 1 Bunsen element; that is to say, a 1 Bunsen element current sent along No. 2 wire produced the same effect upon the Hughes apparatus as did the induced current. These results ought not to be a matter of surprise, since, by reason of the wires' length and their condensing capacity, there are at the uninsulated extremity of the inducing wire very strong charges which develope currents on the induced wire, one of whose extremities is to earth.

In the second case, which accords with practice, the other ends of the two wires were in connection with earth through resistance coils of 500 to 800 kilometres; and it was found that induction likewise took place which differed but little from that observed in the previous case. I was unable to ascertain what was the amount of induction at the second end of the wire; but it is nevertheless certain it must be inferior to that at the first end.

On taking two wires in two different cables, induction was still met with, but of much less strength.

In order to ascertain the influence of length upon the intensity of these phenomena I had the two wires, upon which I experimented, cut in halves. By operating as before upon the first half of these conductors, and upon two other conductors contiguous to one another, I found that the induction observed in the second case was greater than that observed in the first, but less than the double of that same induction. This shows that it increases with the length of the wires, but less rapidly than the length. In other respects I have been unable to determine the exact relation of these inductions.

The induction between two wires of one cable is relatively considerable, and this is a strong argument in favour of separating underground and tunnel wires in preference to having them bound up together.

Throughout my studies I have investigated the influence of the soil around a post upon the flow of electricity to earth, and its propagation on the wires terminating there. To get some idea of this influence, I replaced the inducting wire sometimes by a large condenser, and at other times by a different underground line wire going from the central post office to the Lyons Railway, in order to have no induction current between the two wires under experiment. A rheostat was placed between the earth and the point of junction of the battery's negative pole and the "earth knob" of the apparatus on the second wire.

Everything being thus arranged, the following results were obtained:—

(1). On sending a current into the first wire none was observed on the second wire, both of them being insulated at the other end, and without any rheostat resistance.

(2). When 35 resistance units were used, and a current from a battery of 150 Daniell's elements was sent on to the first wire, currents were set up in the second wire capable of working the apparatus, provided, however, its setting was more sensitive than is required for ordinary work. The induced currents would also work the instrument with its customary setting when a rheostat resistance of 180 units was employed.

(3). The extremities of the two wires being to earth, more striking results were obtained, for then the machine on the second wire worked with its ordinary setting from a current induced by a battery of 150 elements, and with only 30 rheostat units.

These results are easily explained by the theory of the propagation of electricity. They supply the means of finding out whether the earth at a post is good or bad. To ascertain this two condensers, or one condenser and a rather long underground wire, are required. The one condenser should be joined to a strong battery by a switch; the second should be joined up to the other pole of the battery through a very sensitive galvanometer or a polarised electro-magnet apparatus: both condensers should lead to different earths, the *latter* communicating with the earth around the post. If, when sending currents upon the first conductor, the apparatus on the second does not act, the earth around the post is good, for it must have too much resistance when the apparatus does act.

In the same year, 1869, I strove to ascertain whether any appreciable induction currents, inconvenient to the service, would be manifested between the aërial wires which were to be joined to the underground cables from Paris to Juvisy. For this object I erected one day in the signal house of the underground line, at Juvisy, when it was fine and the wires were well insulated, a Hughes apparatus on one of them, between Juvisy and Mâcon, which call A, to earth at Juvisy; and for more than half an hour I received in a perfect manner all the messages from Paris for Florence, effected by another wire, which call B, adjacent to that from Juvisy and Mâcon. On making the line current successively enter by each of the extremities of the coils, I assured myself that the currents which worked the apparatus were really due to induction, and were not derived. When Florence sent to Paris upon B, induction currents were found upon A, but they were much less feeble than when Paris sent to Florence. This can also be accounted for by the theory of the propagation of electricity. Between Paris and Mâcon there were upon the route of these two wires underground portions of about 1000 metres length; but previous experiments showed that the induction upon these portions could only have given very feeble currents: the observed induced currents could therefore have been almost due to the aërial parts of the wires alone.

In 1873 I resumed these experiments upon several wires, and notably on two wires (C and D) which were adjacent to one another upon the same posts between Marseilles and Lyons. Stationing myself at Marseilles and placing the instrument on C—disconnected at Lyons —I received (when the instrument was suitably arranged) almost all the messages from Marseilles for Paris sent on D wire. These experiments were made, first when the underground sections from Marseilles and from Paris were in the circuit of wire C, and again when these portions were cut out; the results were almost the same in either case. When Paris sent to Marseilles by wire D, the phenomena of induction were not appreciable in my apparatus.

It was likewise observed on cutting wire C successively at Valence and Avignon, that induction diminished with the length; for when the disconnection occurred at Avignon, scarcely any signals were obtained, as was expected from the results of previous experiments.

EXPLANATION OF MR. L. SCHWENDLER'S DOUBLE BALANCE METHOD OF DUPLEX TELEGRAPHY.

By W. P. JOHNSTON, Calcutta.

General Theory of Duplex Telegraphy.

1. Duplex Telegraphy signifies the simultaneous transmission of two messages, in opposite directions, through a single wire.

2. In ordinary or single telegraphy the signals are invariably produced in the same manner, or by currents that arrive through the line from the distant stations, supposing the line to be worked on open circuit; whereas in duplex telegraphy the signals are made not only by currents that arrive through the line, but also by currents that do not arrive, or, in other words, by the battery of the receiving station: this is always the case when the time of making contact with the signalling keys at both stations is simultaneous, and signals made in this manner are designated "duplex" signals, to distinguish them from the ordinary "single" signals. During the transmission of two messages, in opposite directions, "single" and "duplex" signals must necessarily follow one another in accidental succession; in fact, any one signal may be partly a "single" and partly a "duplex" signal, and therefore—to secure regularity of working and to avoid constant adjustment of the receiving relays—both the "single" and "duplex" signals must be of the same strength: this indispensable condition is obtained by the ratios the different resistances bear to one another, and of this I shall speak further on.

3. As the receiving instruments must be permanently

connected up with the line, the receiving instrument of any station must remain entirely unaffected when that station alone is signalling,—that is, it must at all times be free to record the signals sent from the distant station.

4. A telegraph line worked on the duplex system has the following advantages over a line of two wires worked singly:—

(*a.*) The charges and discharges can be exactly balanced, *i.e.*, eliminated from the receiving instruments.

(*b.*) A line worked duplex represents two lines far apart from one another, or on separate posts, for the disturbances due to voltaic induction between two long parallel lines cannot be experienced.

Explanation of the "Double Balance Method with Hand Adjustment."

5. It will be convenient to give here the general results of Mr. Schwendler's investigation, and these are as follows:—

(*a.*) The branches of the bridge, with the exception of the one lying opposite to the line, must be equal to each other, and severally equal to half the measured conductor resistance of the line.

(*b.*) The branch lying opposite the line should be equal to the sixth part of the measured conductor resistance of the line, and in this—the smallest of all the branches—re-adjustment of balance should be made only.

6. From the development of these general results it will be evident that they fulfil the following conditions:—

(*a.*) The irregularity of signals in the one station is entirely independent of the irregularity of signals in the other station, just as in single telegraphy.

(*b.*) The irregularity of signals in each station is due only to balance not being rigidly established.

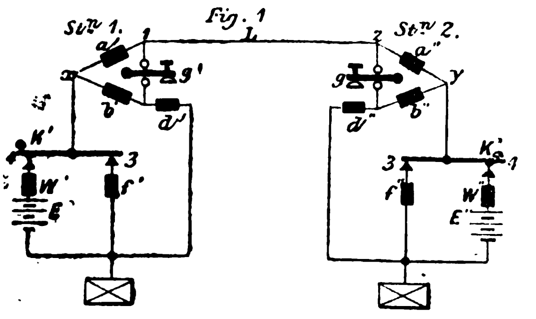
(*c.*) If balance in either station is disturbed, a single adjustment in the branch (*b*) lying opposite to the line will re-establish that balance.

(*d.*) Any disturbance of balance, no matter to what cause it is due, will have the least possible effect on the received signals.

(*e.*) Maximum current at balance.

(*f.*) Maximum magnetic effect of the maximum current on the receiving instrument.

7. Fig. 1 gives the diagram of a line with duplex instruments at either end of it. The arrangement of the resistances is the same at both stations, but the corresponding resistances are not necessarily equal, for measurements taken from Stations I. and II. for the conduction resistance of the line will not, as a rule, agree, owing to to the resultant fault being nearer to one station (*vide* Testing Instructions).



8. K' and K'' represent the signalling keys (to be described hereafter); g' and g'' represent the receiving instruments, consisting of Siemens's or d'Arlincourt's relays; a' a'', b' b'', d' d'', f' f'', W' and W'' represent electrical resistances (ordinary resistance-boxes); L represents the measured conduction resistance of the line; E' and E'' represent the signalling batteries, their internal resistances being B' and B'' respectively.

9. The resistances from point 1 through Station I. to earth, and from point 2 through Station II. to earth, or the complex resistances at Stations I. and II., we will call ρ' ρ''* respectively.

10. The best arrangement for these resistances is as follows:—

$$a=g=d=f=\frac{L}{2}$$

and—

$$b=\frac{a}{3}=\frac{L}{6}$$

if the line has no leakage: if the line has an appreciable leakage, then—

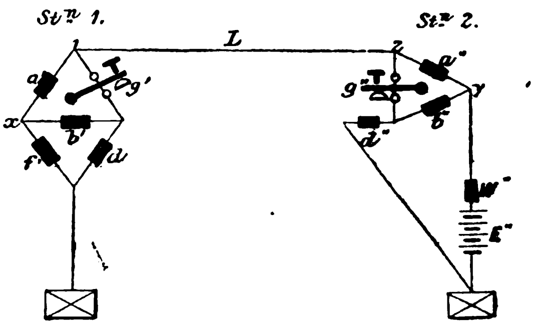
$$a=g=d=f=\frac{L}{2}$$

will be still approximated, and b will increase from $\frac{L}{6}$ to a certain limit. But as the resistance of g (the receiving instrument) is fixed from a number of tests taken of the line, the resistances a, d, and f also become fixed and severally equal to g.

11. On depressing the key k' at Station I., for the purpose of transmitting a signal to Station II., the sent current divides at the point x, where the following paths are open to it, viz, through a', g', d', and through b', g', L; and the duplex arrangement at Station II., or, in other words, the current at the point x, enters a bridge the four branches of which are the resistances a', b', d', $L+\rho''$ (the line and the complex resistance at Station II.): the galvanometer branch of this bridge being g', clearly g' will receive two currents in opposite directions, and unless $a'\,d'=b'(L+\rho'')$ these currents will be unequal, and their difference will act on the relay g', influencing the signals sent from Station II. As mentioned above, the resistances a' and d' are fixed; and as the resistance of the line (L) cannot be altered, the resistance in the branch b' (the branch lying opposite to the line) must be increased or decreased as may be found necessary till $a'\,d'=b'\,(L+\rho'')$, *i.e.*, the branch b' must be adjusted till, on depressing the key k', the relay g' receives no part of the current.

12. Suppose now the branches b' and b'', at Stations I. and II. respectively, to be adjusted so that $a'\,d'=b'(L+\rho'')$,

Fig. 2



and that $a''\,d''=b''(L+\rho')$, then either station can send signals without working its own relay, and this condition is called "balance for permanent current." On tracing the arriving current at either station we shall see why adjustment is confined solely to the "b" branch. Depress key k'' at Station II. and the current divides at the point y

* Letters used without any accents refer equally to both stations.

—one part goes through b'' and d'' to earth, the other part goes through a'' out to line, no portion of it going through g'', because $a''\,d''=b''(L+\rho')$: the current that arrives at the point 1 at Station I. has the following paths open to it through g', b', f' and through a', b', d', or, in other words, at the point 1 it enters a bridge (see Fig. 2) the four branches of which are the resistances a', f', g' (the receiving relay), and d'. The galvanometer branch of this bridge being the resistance b', clearly b' will receive two currents in opposite directions, and unless $a'\,d'=g'\,f'$ those currents will be unequal, and their difference will pass through b'; but a', d', g', f' are all equal, and therefore no part of the current arriving at point 1 from Station II. passes through b',—and it is for this very reason that adjustment is confined solely to the "b" branch, because any alteration of the resistance in this branch under these circumstances has no effect whatever on the arriving current, *i.e.*, when one station has obtained balance for "permanent current" the other distant station may alter the resistance in its "b" branch from zero to infinity without disturbing that balance in the distant station in the slightest degree. The equation $a\,d-g\,f=0$ is called "*the immediate balance condition*," and the rigid fulfilment of this condition is of the greatest practical importance to the success of duplex working.

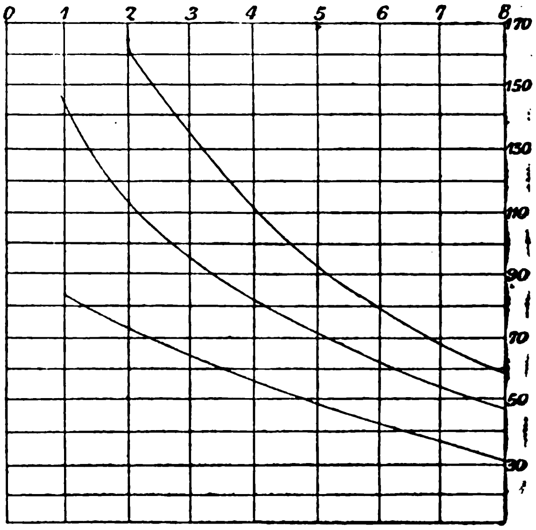
13. The reason why the method is called "*the double balance method*" is now clear, for there is balance in the "g" branch for the outgoing current, and there is balance in the "b" branch for the incoming current. In all the other known duplex methods, balancing the outgoing current at one station disturbs invariably the balance at the other station, and therefore, if balance in any one station has once been disturbed, it can be regained only by successive adjustments in both stations. This is a most serious objection to duplex working, and has been entirely avoided by the "double balance," where, moreover, the adjustment of balance is conveniently confined to one branch (b) only.

(To be continued).

ON THE ELECTRIC RESISTANCE OF AIR.

"IN the case of metals" (writes M. Oberbeck, in a recent number of *Poggendorff's Annalen*) "we obtain nearly the same numerical values for their relative conductivity for electricity and heat. Paalzow has shown that there is not such an agreement in the case of liquids which are decomposed by the current. On the other hand, gases might present such a relation: at least hydrogen seems to excel the other gases in conductivity for heat and electricity. While, however, we have had several recent determinations of resistance of solid and liquid conductors, the preliminary question has not been decided, for gases, whether the passage of electricity through them, in certain circumstances (with high temperature or low density), is to be conceived as qualitatively similar to that through solid conductors. Hence, in one of the most recent investigations on the subject, MM. Wiedemann and Rühlmann quite depart from the usual methods of determining resistance, and have treated the question with quite other means. However interesting the results of this research may be, they yet furnish no conclusions as to electric resistance proper, but only as to the resistance presented by the gases at the beginning of the discharge. Hittorf, however, has found that with low density of gas the resistance of the negative glow light—*i.e.*, the resistance at the cathode—greatly exceeds the proper resistance of the gas; and on the other hand, with greater pressure, it is chiefly the positive light—*i.e.*, the glowing gas traversed by the electric current—that occasions the weakening of the current. Hence, with ordinary conditions of pressure, we may regard the passage of electricity through a gas as passage through a solid conductor. It seemed to me interesting to establish this fact once more, and therewith determine the resistance, first, of air."

With this view M. Oberbeck examined the resistance in the path of the induction spark. His experiments were arranged as follows:—A spark-micrometer with steel points, a galvanometer, and an easily variable resistance (dilute blue vitriol solution in a thin glass tube), were inserted in the circuit of an induction-current. The resistance of 1 c.m. of the liquid column might be taken at about 600 Siemens units. With the aid of a tangent galvanometer in the inducing circuit, the current in the latter was noted, and rendered constant. Each experiment was several times repeated, and the mean taken. The rheostat was first brought to zero, so that in the induction circuit there was only the resistance of the induction-apparatus, the galvanometer, and the spark. Then a spark-interval of 1 m.m. was arranged, the interrupter worked, and position of equilibrium of the galvanometer needle (soon becoming constant) observed. The spark interval being now increased 1 m.m., another observation was made, and so on. Then the current was reversed, and the same processes were repeated. At 9 m.m. the spark discharge ceased, changing to the glow. The galvanometer needle then went back to zero, indicating that only a very small fraction of electricity streamed out. In the second and third series of observations the resistances 20 c.m. and 50 c.m. of the blue vitriol tube were commenced with.



M. Oberbeck gives the numerical results in a table, and in the accompanying curves to correspond, in which the spark-lengths are abscissæ (1, 2, 3, &c.) and the current strengths ordinates. The three curves correspond to the resistances 0 c.m., 20 c.m., and 50 c.m. respectively (the upper first).

The numbers were now to be utilised for estimation of resistances. It was important to obtain the resistances of the spark path for equal strengths of current; so M. Oberbeck takes, from the three intensity curves, those abscissæ (spark-lengths in millims.) corresponding to equal current strengths. Then, subtracting the spark-length with 20 c.m. resistance from that opposite it, with 0 c.m. resistance, he obtains that spark-length whose resistance, with the selected current strength, = 20 c.m. And similarly with the two other series. Thus series of spark-lengths are obtained whose resistances are respectively equal to 20 c.m., 30 c.m., 50 c.m.: these are also tabulated.

Hence may readily be deduced the resistances of 1 m.m. spark-path, as functions of the current strength (i), and expressed in centimetres of the liquid serving as resistance. These are given in the following table:—

140	11·7	—	—
130	11·1	—	—
120	10·5	—	—
110	10·0	—	—
100	10·0	—	—
90	10·5	—	—
80	11·1	10·3	10·6
70	11·7	10·7	11·1
60	12·5	12·0	12·2
50	—	12·0	—

It is remarkable that the numbers diverge but slightly from each other, while, as we know, the aspect of the spark phenomenon is quite different in short and in long sparks. The variation of the numbers is explained, if we consider the actual lengths of the spark, from whose differences the resistances are calculated. According to external appearance the section of the spark-path increases at first, with the elongation of the interval, to a maximum, reached at about 3 to 5 m.m.: from that it diminishes. With mean length of spark, therefore, the resistance of a 1 m.m. path must be about the smallest. With greater intervals and smaller current strengths an increase of the resistance occurs, arising partly from diminution of the section.

"Thus we have evidence," M. Oberbeck concludes, "that it is possible to fix the numerical values for the resistance of glowing intervals of air just as well as for solid or liquid conductors. The next task will be to extend the research to other gases."

ON UNIPOLAR CONDUCTION OF ELECTRICITY THROUGH GAS LAYERS OF DIFFERENT CONDUCTIVITY.

In the early part of this century it was shown by Erman that the flames of a large number of organic substances conducted preferentially positive electricity. His researches have since been confirmed and extended by Hankel, Becquerel, Hittorf, and others. Hankel proved the same relations for a mixture of inflamed gases; Becquerel for unmixed gases (CO_2, H, air, &c.) heated to the red-heat of solid bodies. Hittorf has recently shown that also in rarefied gases made to glow with the induction current, there is a peculiarly strong resistance at the negative pole.

Phenomena of unipolarity present themselves if a galvanic current be sent through a glowing mass of gas by two electrodes of different size, *e.g.*, a plate and a wire. The current has a greater intensity when the plate is cathode. But this is only one form of unipolar conduction: the phenomena are also obtained when two equal-sized electrodes are inserted in a gas-flame. The question arises—What are the circumstances conditioning the unipolarity in this case?

In a recent paper in *Poggendorff's Annalen* (No. 4, 1875) the subject is investigated by M. Ferd. Braun. After describing his method of experiment, he discusses successively the connection of unipolarity and (what he calls) the *flame current*, the dependence of the resistance on the intensity of the current, and the influence of widening the distance between the electrodes on the resistance of the flame. The following is his *resumé* of results:—

1. Whenever two metallically-connected wires are inserted in the glowing gas-mixture of a flame there arises, in general, a current, formed by the superposition of two currents; a *thermo-current*, due to the different temperature of the wires, and another caused by the difference of surrounding of the electrodes. This latter current, which one may regard as analogous to the current of a galvanic battery, I name the *contact-current*; the algebraic sum of the two, the *flame-current*.

2. We may make the contact-current greatly exceed the thermo-current, by surrounding one of the two electrodes (as nearly equally warm as possible) with gases which are different from the gases surrounding the other electrode. Under such conditions, it appears that a current, the electromotive force of which does not exceed that of the flame-current, has always less resistance in the direction opposite to the contact-current, and mostly, also, in the direction opposite to the flame-current, than with it.

3. If we would explain the phenomena of unipolarity by a resistance at the cathode increasing with the density of the current, no simple law appears for this, as *e.g.*, that it is proportional to the density of the current.

4. It is thus explained how the intensity of the current varies in a very complicated way with the electromotive force.

5. It is shown by experiment that at the anode also—even when it is surrounded by comparatively good conducting gases—there is a resistance increasing considerably with the density of the current.

6. The intensity of a current which flows in the direction of the better conductivity decreases when the electrodes, placed in a horizontal section of the flame, are approximated to each other. On reversed direction of current the behaviour is normal, *i.e.*, as in the case of a metallic or electrolytic conductor.

THE TELEGRAPH IN RUSSIA.

From a Report of the Russian Telegraphic System for the year 1873 we learn that the construction of electro-magnetic telegraph lines in Russia began in 1853. Premising that a *werst* = about ⅔ of a mile and a *rouble* about 3s. 4d., we take from the first of the tables showing progress the following figures:—Telegraph lines in 1857, 7325 wersts; telegraph wires, 10,144 w.; number of telegrams, 170,210; receipts in roubles, 427,637. The corresponding numbers for 1873:—72,348; 143,069; 3,431,574; and 4,630,029. The greatest increase of lines and wires was in 1870; yearly average increase, 4020 w. telegraph lines, and 7944 w. telegraph wires. A second table compares home and foreign telegrams, both of which classes show increase—the former most (eightfold from 1860 to 1873, while the foreign have increased fivefold, the official threefold). A third table compares receipts and expenditure. During the first ten years, from 1857, there is a minus of receipts, but during the remaining seven the case is reversed; and the minus disappears, if we leave out the expenses of construction of lines. The excess of receipts over expenditure in 1867 to 1873 is well-marked and steady, notwithstanding the cost of construction (in 1871 and 1872 amounting to 769,000 and 902,000 roubles respectively). A fourth table informs us that there were, in 1873, 1474 stations, with 1607 apparatuses of the Morse system and 76 of the Hughes (they are worked by, in all, 51,586 Meidinger elements). On January 1st, 1874, there were 324½ w. line-length of private telegraphs, with 29 stations; the line-length of railway telegraphs, 12,973 w., with 793 stations; that of state telegraphs, 55,644½ w., with 681 stations (wire-length more than double line-length in the former case, nearly double in the latter). Of the foreign telegrams sent in 1873, 33·5 per cent were to Germany, 17·6 to Great Britain, 15·4 to Austria, and 9·8 to France; altogether 76 per cent. The greatest increase was to Sweden (35 per cent on previous year), while there was a falling off to Italy and Greece of 21 and 30 per cent respectively. Most inland telegrams were exchanged in August, fewest in April (about 252,000 as against 212,000); most foreign in September, fewest in December (about 28,000 as against 19,000). The number of telegrams from St. Petersburg was 399,383, and there were 11 stations which sent over 30,000. Comparing the gross receipts with the number of telegrams, we have an average of 1 rouble 26 kop. for every inland werst; 1 rouble 54 kop. for every international. (The kopeck = about ½d.)

NOTES.

The arrangements for the forty-fifth meeting of the British Association, to be held at Bristol on the 25th inst., are approaching completion. The President and Lady Hawkshaw will be the guests of the Mayor, who will inhabit the new Mansion House recently presented to the city by Alderman Proctor. The Secretaries of the various Sections will be lodged at the Queen's Hotel. The following are the officers: — *President-Elect* — Sir John Hawkshaw, F.R.S.. *Vice-Presidents-Elect*—The Rt. Hon. the Earl of Ducie, F.R.S.; the Rt. Hon. Sir Stafford Northcote, Bart., F.R.S.; the Mayor of Bristol; Major-General Sir Henry C. Rawlinson, F.R.S.; Dr. W. B. Carpenter, F.R.S.; W. Sanders, F.R.S. *General Secretaries*—Capt. Douglas Galton, F.R.S.; Dr. Michael Foster, F.R.S. *Assistant General Secretary* — George Griffith, F.C.S. *General Treasurer*—Prof. A. W. Williamson, F.R.S. *Local Secretaries*—W. Lant Carpenter, F.C.S.; John H. Clarke. *Local Treasurer*—Proctor Baker. The following are the Presidents and Secretaries of the Sections:—A. Mathematical and Physical Science. *President*—Prof. Balfour Stewart, F.R.S. *Secretaries*—J. W. Glaisher, C. T. Hudson, J. Perry, G. F. Rodwell. B. Chemical Science. *President*—Prof. A. G. Vernon Harcourt, F.R.S. *Secretaries*—Dr. H. E. Armstrong, W. Chandler Roberts, W. A. Tilden. C. Geology. *President*—Dr. T. Wright, F.R.S.E., F.G.S. *Secretaries*—L. C. Miall, E. B. Tawney, W. Topley. D. Biology. *President*—P. L. Sclater, F.R.S. *Secretaries*—E. R. Alston, Prof. W. R. M'Nab, F. W. Rudler, Dr. P. H. Pye Smith, Dr. W. Spencer. E. Geography. *President* — Major-General Strachey, F.R.S. *Secretaries*—H. W. Bates, E. C. Rye, F. F. Tuckett. F. Economic Science and Statistics. *President*—James Heywood, F.R.S. *Secretaries*—F. P. Fellowes, T. G. P. Hallett, E. Macrory. G. Mechanical Science. *President*—William Froude, F.R.S. *Secretaries*—W. R. Browne, H. M. Brunel, J. G. Gamble, J. N. Shoolbred. The President's Address will be delivered on Wednesday, August 25, at 8 p.m. On Thursday evening there will be a *Soirée*. On Friday evening, at ½-past 8, Mr. Spottiswoode will discourse on "The Colours of Polarised Light." On Saturday evening Dr. Carpenter will lecture to working men on "A Piece of Limestone." On Monday evening, the 30th inst., Mr. Bramwell will lecture on "Railway Safety Appliances." On Tuesday evening a second *Soirée* will be held, and on Wednesday, September 1st, the concluding General Meeting will be held.

The Peruvian exploring vessel *Chalaco* has been engaged in taking preliminary soundings between Chorrillos, in Peru, and Caldera, in Chili, with the view of laying the submarine cable between these two points. The route examined was on a line starting from Chorrillos, and passing within 4 miles of the island of San Gallan, forming here a slight deviation towards the coast, and then running parallel to it for about 20 miles, about 8 or 10 miles off. The depth of the sea as far as San Gallan is not great, not exceeding a maximum of 100 fathoms, the bottom being all along a mixture of mud and gravel. From thence the soundings began increasing as far as the Morro of Chala, where a depth of 600 fathoms was noted. The submarine exploration, so far as it goes, proved that no difficulties would be met with in laying the proposed cable.

It is contemplated to connect the Kangra Valley with the general telegraph system, at an early date. This measure, states the *Times of India*, besides serving the military stationed at Dhurrumsala, Dalhousie, and Fort Kangra, will be a boon to the large tea-planting interest in the Valley.

The Bangalore correspondent of the same journal says that the revised scheme for the Educational Department came into force on the 1st of July. The High School at Bangalore is to be called "Government College," and a Vice-Principal for the College is to be got out from England: his special attainments are to be Natural Science, Philosophy, and Chemistry. The salary attached to the post Is very small.

The average time occupied in the transit of messages by the Indo-European Telegraph Company between London and India *viâ* Teheran, including messages for Penang, Singapore, China, Japan, Java, and Australia, during the week ending August 6, 1875, was 1 hour 23 minutes.

A project has been set on foot to connect all the public clocks of Paris with the chief clock of the Observatory. A telegraphic wire will unite it to the Luxembourg clock, which will in turn, by means of a series of wires, communicate its time to the Exchange, Law Courts, Town Halls, Churches, and most of the public buildings. The Observatory regulating time-piece is placed in the catacombs, so as to be away from the trembling influence of the ground; the time-piece scarcely varies one-tenth of a second in a year.

The following is an interesting example of the use of the Gramme machine for lighting purposes. The premises (a large iron foundry in France) are lighted by four lamps, each in electrical union with a Gramme machine, which are placed adjacent to the foundry, and 1700 rotations a minute are effected by means of a steam-engine used in the ordinary work of the factory. Each set of carbons is surrounded by a diffusing globe, so that the light does not appear as blinding points, but as four large shining white globes. The area of the building is about 182 feet by 91 feet, and the lamps are placed at a height of 17 feet above the ground in the corners of a rectangle 70 feet by 46 feet. This arrangement is found to suit admirably; the intensity of the light is nearly constant, and scarcely any shadow falls, on account of the rays from the four lamps crossing each other's paths. The cost, as far as at present ascertainable, is estimated thus:—The carbon poles, 0·250 metre each long = 0·500 m. for every lamp; the section equalling 6 square m.m. The upper carbon is consumed in three hours, the lower in five hours; hence the two may be reckoned as burnt away in four hours, or 0·125 metre per hour per lamp. This, at 1·75 francs a metre, equals 0·22 franc per hour per lamp; and to this must be added an estimated cost of 0·04 franc for driving

each machine. The total expense thus becomes 1·04 francs per lamp per hour, *plus* the interest upon the cost of the machine and charge for its wear and tear.

An exhibition of all kinds of electrical and telegraphic apparatus will probably be opened in Paris in December. We hope to give further particulars in our next issue.

There is at length a fair prospect that telegraphic communication with the Channel Islands and the Isle of Man will be re-established within a very short time. The cable ship *Caroline* is at the present moment shipping at Silvertown some twenty-five miles of new cable for the Channel Islands, to replace a great portion of the faulty cable now submerged between Dartmouth and Guernsey; and it is hoped that she will drop down the river about Thursday on her way to Dartmouth. Should fine weather be experienced, she may have completed this portion of her undertaking in about a fortnight from now, and this being so, she will proceed to the Isle of Man to recover a portion of the faulty cable submerged there, and to lay new shore ends in readiness for a new deep sea section of cable at present in course of manufacture. A month or six weeks of fine weather will probably suffice for the completion of the whole of these important operations; and towards the middle or end of September we may hope to be once more in direct communication with the Channel Islands and the Isle of Man. The Post Office has been singularly unfortunate with its cable communications recently, and has had to incur great cost in order to maintain the service with isolated parts like Jersey and Guernsey. We are not aware, remarks the *Times*, whether the traffic to the Channel Islands and the Isle of Man is of a remunerative character; but, assuming that it is not, that would be no good reason why they should not enjoy the benefits of telegraphic communication, and the circumstance is worth bearing in mind in the present circumstances of the Telegraph Department. It is true that both islands had telegraph communication under the old telegraph *régime*; but so far as the charge for messages was concerned they might have been situated in France or Germany, it was so excessive. They were indeed "foreign parts" to the English telegraph system of those days.

ELECTRICAL SCIENCE IN FOREIGN JOURNALS.

(This column is devoted to a list of Electrical Memoirs published in Foreign Journals. Those of importance will be either translated in full or given in abstract.)

Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences. Vol. lxxxi., No. 13, July 26, 1875.

Distribution of Magnetism in Bundles of Very Thin Plates of Infinite Length.—By Jules Jamin.— A continuation of former papers on the same subject (see Electrical News, pages 16, 27, and 52). It will appear fully translated in an early number.

Researches upon Phenomena Produced by High Potential Electric Currents and their Analogies with Natural Phenomena.—By G. Planté.—A translation of this interesting article will be given in full in our next number. In it M. G. Planté continues his observations and experiments detailed at page 7 of this journal.

Les Mondes. Vol. xxxvii., No. 13. July 29, 1875.

Contains no electrical or telegraphic news.

The Telegrapher, July 3, 1875.

Fifteen Years' Telegraphic Progress.

Telegraphic Signals — How Trains are Run Through Bergen Tunnel.—(From the *New Jersey Evening Journal*). It is claimed by the managers of the Erie Railroad that the system of signals in use at their tunnel through Bergen Hill is the safest and best that is in use at the present day for the running of trains through a tunnel. The electric signals by which this plan of running trains is carried out, are connected by insulated wire or covered wire running over the hill, thus making the connection between the two signal houses which are at each end of the tunnel. In each of these houses is an electrical signal machine, which is so arranged that when the key is closed at one end of the tunnel, the bell strikes four times at the other end, and by this the signalman knows that a train has just passed out at the other end all right, and that he can let in another. It is a rule that two trains shall not be let into the tunnel at one time on the same track, and that on the rear of each train must be a red light, and the signalman, whose duty it is to send back the signal "All right" must see that the train had such lights on the rear of the car when it passed by the signal house. In a busy time the two roads that use this tunnel, the Erie and the D., L. and W., often run as many as 300 trains through in a day, and it is often the case that two trains bound west come up to the mouth of the tunnel, or the place where they are all obliged to stop before going in, at nearly the same time, and the train that stops first has the right of way in the tunnel, the other not being allowed to start in until the one preceding it has been signalled back as having passed through all right. Should a train be gone over fifteen minutes without being signalled back as all right, the waiting train will be sent in with a note to the signalman at the other end to send back two signals when the last train passes him, and he is also cautioned to look out and to proceed in a cautious manner. It takes on an average about six minutes for a train of ordinary length to go through. Should any accident happen to a train in the tunnel it is the duty of the conductor to send a man back with torpedoes and a lantern to signal trains of danger ahead. Should two trains be let into the tunnel with an interval of fifteen minutes, and no signal of their safe arrival be sent back to the end from which they started, no more trains would be let in until a man had walked through the tunnel and back, and seen that no obstruction was in the way. So that if a train should break in two in the middle while in the tunnel, there would be no accident, if all hands did their duty. The way in which trains are signalled from the houses during the day, is by a large wooden circle, which is on the top of the signal house, it standing with the white side visible when a train is in the tunnel, and the red one when "all's well." In the night a red and white light is used in its place. It takes twenty cups of an ordinary battery to keep the thing in working order, and Mr. Conklin, the superintendent of the tunnel, who has held his present position for the last six years, is always there during the day time, and it is mainly through his exertions that the present system of signals used here is so perfectly managed. The tunnel has two tracks through it, and the same rules apply to the one track as well as the other, as there is no rule prohibiting the running of the two trains through on different tracks at the same time, but trains must always take the right-hand track in going through. The signalman knows by

the number of strokes of the bell just what has transpired at the other end, and he signals the engineer accordingly.

Electrical Arrangement of the New Palace Hotel at San Francisco, Cal.—This is said to be the largest hotel in the world, and will contain 1200 rooms. There will be one electrical annunciator on each floor, containing from 120 to 160 numbers each, with its special service in constant attendance. Each room is provided with a push button, communicating with the office, also with an automatic thermostatic fire alarm, which, by a slight increase in the temperature of the room, rings the bell continuously in the office, and at the same time announces the room from which the alarm proceeds. There will be about 160 electrical clocks throughout the building, all governed by one regulator in the office. There are already about 120 miles of copper insulated wire running through the building from the different rooms to the main office. There will be seven annunciators in all the building, besides one small one in each elevator. Each floor has a tube receptacle for letters for the Post Office. There is a pneumatic dispatch tube, by which messages and parcels can be instantaneously sent to any point on the different floors. The watchman's tell-tale indicator in the office faithfully reports the intervals of the watchman upon his regular rounds both day and night, and in other respects indicates the method and manner of his attention to duty.

The Galvanic Battery.—An abstract of the Count du Moncel's report on the Chutaux battery.

July 10, 1875.

Battery Covers.—See Electrical News, vol. i., p. 44.

A Curious Magnet.—A notice of M. Jamin's paper in *Comptes Rendus* of April 5, referring to Galileo's letter to Curzio on a magnet which had the property of attracting one and the same pole of a bar of steel when at a distance, and of repelling it when near, whilst it attracted soft iron at any distance. M. Jamin has found that a steel bar may be magnetised to saturation by a very powerful current, and the magnetic fluid will penetrate to the very core of one of his halves, which he calls *positive*. This being obtained, the same bar is exposed to an inverse current, which, very weak at the outset, gradually increases in intensity, and determines a boreal or *negative* magnetisation, merely superficial at first, but going down deeper by degrees, leaving, however, positive strata further down. The outer surface is now carried off by corrosion in an acid, so that the exterior negative surface is removed and the subjacent positive strata are brought to light. A bar thus prepared will behave like Galileo's steel in the presence of a common magnet.

New Absolute Galvanometer.—A description of the galvanometer described by Professor Guthrie, as constructed for him by the Messrs. Elliott. Its principle depends upon the computation of the strength of the current by the measurement of the mechanical force necessary to bring to a given distance from one another two electro-magnets, which are affected by the current in such a fashion that they repel one another. The galvanic current whose force is to be measured, coils around two fixed soft iron masses, rendering them magnetic, and then around two movable soft iron masses suspended by a vertical thread. Many of the laws of electro-dynamics may be readily illustrated by this instrument, and not only may different currents be compared with the greatest accuracy, but the absolute mechanical value of the current may be at once arrived at.

Magnets for Electro-Motors.—Magnets or armatures for electro-motors may be softened as follows:—Heat the iron to an even dull red heat all over; and if the surface of the iron has not been faced off in a machine, lightly file it to remove the scale, and then immerse it in common soft soap, allowing it to remain therein until it is quite cold. Then re-heat the magnet to an even red heat whose redness is barely perceptible, and bury it in pulverised lime, wherein it must also remain until quite cold, when the metal will be found as soft as it is possible to make it, and the blade of an ordinary penknife will cut it. At the second heating the iron will emit a light blue flame, showing the effect of the immersion in the soft soap. The conductibility of the magnet may be, by this process, very much increased.

American Artizan. Vol. xix., No. 7. July, 1875.

Bean's Pneumatic Electric Gas Lighting Apparatus.—The novelty of Mr. Bean's invention consists in a combination of compressed and rarefied air to open and close the gas-cocks, and an electro-galvanic current, affording at the same instant a spark to light the gas flowing through the gas jet, so that a single operator can, without leaving his office, at will light or extinguish all the street-lights of a city or town.

Archives des Sciences Physiques et Naturelles,
June 15, 1875.

Physico-Chemical Forces and their Interpretation in the Production of Natural Phenomena.—A review of M. Becquerel's recently published work on this subject. The first chapter, we are told, treats of general physics, and gives many curious facts and relations; *inter alia*, the author describes his researches on phosphorescence, and on photographic reproduction of colours of the solar spectrum. But the interest of the book centres in the chapters on electro-capillary actions; the principle of which is that "when two liquids containing, in solution, different substances capable of reacting chemically on each other, are separated by a membrane permitting them to mix together very slowly, there is produced through its walls, a continuous electric current which may cause particular chemical effects. If the resulting compounds are insoluble, they become attached to one of the surfaces of the membrane; in the contrary case, they are distributed throughout the solutions, where they concur in new operations." The fundamental experiment is putting a cracked tube containing nitrate of copper solution into a vessel containing a solution of sulphuret of sodium. The interior of the crack becomes coated with metallic copper, and if the two solutions be then connected, respectively, with the electrodes of a galvanometer, an electric current is observed, to which the nitrate furnishes positive, and the sulphuret negative, electricity. M. Becquerel has succeeded in producing, by his method, several bodies of a composition and crystalline form identical with those of certain natural minerals (malachite, *e.g.*); and one can see that electro-capillary currents must play an important part in formation of crystals in the fissures of rocks. He also studies the electro-capillary currents occurring in processes of animal and plant life. Further, comparing the electro-motive forces produced by action of water on acid and basic solutions, and during the reaction of several salts on each other, he shows that the results are fully in accordance with those of thermo-chemistry; and that, in particular, water plays, in double decompositions, a predominating *rôle*, as M. Berthelot's researches have already demonstrated. M. Becquerel proves, in fact, that the electro-motive force resulting from reaction of two neutral solutions is always equal to the algebraic sum of the electro-motive force resulting from the distinct action of each of the solutions on the water of the other. He has thus found that the electro-motive force produced during hydratation of acids and bases, diminishes in proportion as the degree of hydratation increases; as is the case also with the heat developed during formation of hydrates. Where an acid solution is made to act on an alkaline, the electro-motive force = the sum of the electro-motive forces resulting from formation of the corresponding hydrates, and the direct action of the anhydrous acid on the anhydrous base. "*En resumé*, the total electro-motive force developed in a chemical transformation depends only on the initial and the final

state of the system of reacting bodies; a result conformable to the principle of calorific equivalence of chemical transformations." The last chapters of the book are devoted to terrestrial physics and meteorology; the author giving some valuable conclusions on the controverted topics of volcanic phenomena, and the origin of atmospheric electricity. He also studies the distribution of temperature and of electricity in the interior of plants.

Action of Magnets on Rarefied Gases Contained in Capillary Tubes, and Illuminated by an Induced Current.—M. Chautard.—(From *Comptes Rendus*).

Dingler's Polytechnisches Journal, July 1.

Some Remarks on the Combination of Duplex Telegraphy, with the Sending of two Messages Simultaneously in the Same Direction.—Professor Zetzsche.—See page 41.

Electric Photometer of Dr. Werner Siemens.—This was described by Dr. Siemens at a meeting of the *Verein für Gewerbefleiss*, in June. Reserved for separate notice.

COMMERCIAL NOTES.

The traffic receipts of the Direct Spanish Telegraph Company (Limited) for the month of July amounted to £1834, against £1349 for the corresponding period of last year. The average time occupied in the transmission of telegrams between Madrid and England, *viâ* Santander, during July, was three hours and nine minutes (including transmission over Spanish land lines).

The Eastern Extension, Australasia, and China Telegraph Company (Limited), announce that their traffic receipts for the month of July amounted to £20,225, and £19,641 for the corresponding period of 1874.

The Eastern Telegraph Company's traffic receipts for the month of July amounted to £31,419, and to £27,247 in the corresponding period of 1874.

The traffic receipts of the Brazilian Submarine Telegraph Company (Limited) for the month of July amounted to £10,230, as against £8037 for the corresponding period of 1874.

The traffic receipts of the West India and Panama Telegraph Company (Limited) amounted in May to £4500, as compared with £2678 in the corresponding period of 1874.

An extraordinary general meeting of the shareholders of Hooper's Telegraph Works (Limited) was held on the 4th inst. at the Cannon Street Hotel, Mr. J. Dunlop (chairman of the company) in the chair. The meeting was one of form. On the motion of the chairman, seconded by Mr. Seymour Grenfell, the following resolution, passed at the meeting of July 20, was confirmed:—"That the regulations of the company be altered by striking out the words in the 37th clause of the articles of association of the company beginning at the word 'provided,' and ending with the words 'paid up.'" The words omitted from the above clause cancelled the restriction that the total amount of money to be borrowed should never exceed one-third of the capital of the company for the time being actually paid up.

The ordinary general meeting of the Globe Telegraph and Trust Company (Limited) was held on the 30th ult. at the City Terminus Hotel, Mr. J. Pender, M.P., presiding. The report stated that the net revenue of the company for the year, after deducting expenses, amounted to £156,539, which, with the balance brought forward, made a total of £158,154. From this the directors had deducted £2625 in respect of the expenses of formation of the company and special expenses of the proposed new issue of shares; £108,508 had been distributed in interim dividends; and the directors now recommended the payment of a final dividend for the year of 3s. per share on the preference shares, and of 2s. 6d. per share on the ordinary shares, making a total dividend for the year of 6 per cent upon the preference and 5 per cent. upon the ordinary shares, leaving a balance to be carried forward of £9327. Since the date of the last report 25,437 shares of the Brazilian Submarine Telegraph Company (Limited) had been exchanged for the same number of ordinary shares of the Globe Company. In pursuance of the resolutions of the shareholders at the extraordinary general meeting held on the 11th of May last, the Board issued a prospectus inviting tenders of stocks and shares of other telegraph companies in exchange for the shares of the Globe Company, but the applications did not warrant the directors in making an allotment. This was attributed to the extraordinary depression in trade throughout the world, which had naturally affected the shares of submarine telegraph companies. The chairman said that the Globe had maintained its position, and he believed that with good trade the companies whose shares they held would have better dividends, and of course they would participate in the increase. The report was adopted after some discussion, and the retiring directors, Mr. Cyrus W. Field, Mr. W. Ford, and Sir D. Gooch, M.P., and the retiring auditors, Messrs. W. Newmarch and J. G. Griffiths, were re-elected.

The India-rubber, Gutta-percha, and Telegraph Works Company (Limited) have received news by telegraph of the successful laying and completion of their cable between Callao and Islay, in Peru. This section, about 460 miles in length, is the first of a series of cables, with stations at Arica and Iquique in Peru, and Caldera in Chili, which will place those ports, as well as Lima and Valparaiso, in telegraphic communication with Europe, first, by the Transandine wires and the Brazilian cable system, and ultimately by the Isthmus of Panama, when a cable shall have been laid thence to Callao.

The report of the Cuba Submarine Telegraph Company states that the net profits for the half-year ended the 30th June, were £11,302. Of this sum, £3155 has been placed to reserve, raising it to £5000, and the balance, after providing for the preference dividend, admits of a payment at the rate of 6 per cent on the ordinary shares, leaving £852 to be carried forward.

The traffic receipts of the Anglo-American Telegraph Company for the 28th July amounted to £1730; for the 29th, to £1600; for the 30th, to £1490; for the 31st, to £1330; for the 1st August, to £350; for the 2nd, to £760; for the 3rd, to £1340; for the 4th, to £1340; for the 5th, to £1450; for the 6th, to £1470; for the 7th, to £1370; for the 8th, to £400; for the 9th, to £1070; for the 10th, to £1320. The actual daily average for the month of August last year was £1676.

The traffic receipts of the Great Northern Telegraph Company for the month of July this year were 414,381 f.; last year, 410,355 f. Total traffic receipts, 1st January to 31st July, this year, 2,409,858 f.; last year, 2,486,726 f.

The register of new companies for the past week contains the following:—W. T. Henley and Company, Limited, capital £500,000, in shares of £10 and £1 each. The object of this company is to purchase the goodwill of the well-known telegraph engineers and contractors' business of Mr. W. T. Henley. The subscribers, who take one share each, are—Francis Moon, 73, Coleman Street; W. Wallis, St. Martin's Road, Stockwell; C. R. Dyer, Lloyds; J. B. Byers, Priory Cottage, Peckham; J. R. Forster, 11, Abchurch Lane; T. Barker, 168, Alexander Road, St. John's Wood; and J. W. Roberts, 1, Selhurst Park Terrace, South Norwood.

The Master of the Rolls recently decided that the dividend on the first preference shares of the West India and Panama Telegraph Company is cumulative. According to Mr. Abbott's circular, the amount of interest accumulated on these preference shares is £1 per share.

TELEGRAPH SHARE LIST.

Amount per Share.	NAME OF COMPANY.	Amount paid up.	Closing Quotations.
£		£	Aug. 11.
Stock	Anglo-American	100	62—63
10	Black Sea	All	2—4
10	Brazilian Submarine	All	6⅝—6⅞
10	Cuba	All	8¼—8¾
10	Ditto, 10 per cent Preference ..	All	13½—14
10	Direct Spanish	9	5¼—5¾
10	Ditto, 10 per cent Preference ..	All	11¼—11¾
20	Direct United States Cable	All	8⅝—9
10	Eastern	All	6⅞—7⅛
..	Ditto, 6 per cent Debenture	..	102—105
10	Ditto, Exten. Australia and China	All	7⅛—7⅜
10	German Union Telegraph and Trust	All	7¾—8¼
10	Globe Telegraph and Trust	All	5¾—6¼
10	Ditto, 6 per cent Preference	All	10⅛—10⅝
10	Great Northern	All	9½—10
25	Indo-European	All	19—21
10	Mediterranean Extension	All	2¾—3¼
10	Ditto, 8 per cent Preference	All	10—10½
10	Panama and South Pacific	2½	..—..
8	Reuter's	All	9¾—10¼
Stock	Submarine	100	195—205
1	Ditto, Scrip	All	1¾—2
10	West India and Panama	All	2½—3
10	Ditto, 10 per cent Preference ..	All	10—10½
20	Western and Brazilian	All	13¼—13¾
1000 dls.	Western Un. U.S. 7 per cent 1st M.B.	All	106—108
100	Ditto, 6 per cent	All	90½—91½
10	Hooper's Telegraph Works	All	8¼—8¾
50	India-Rubber and Gutta-Percha ..	All	19—20
Cert.	Submarine Cables Trust	100	96—99
12	Telegraph Construction	All	22¾—23¼
100	Ditto, 7 per cent Bonds	All	101—104

PATENTS.

APPLICATIONS FOR LETTERS PATENT.

2633. Francis Robert Lucas, of 38, Old Broad Street, London, for an invention of "Improvements in submarine cables."—Dated July 24, 1875.

2657. William Clark, patent agent, of 53, Chancery Lane, Middlesex, for an invention of "Improvements in circuit closers for electric railway signalling apparatus."—A communication to him from abroad by David Rousseau, of New York, U.S.A. (Complete Specification.)—Dated July 27, 1875.

2707. William Marston Warden, John Muirhead, and Josiah Latimer Clark, all of 29, Regent Street, Westminster, for an invention of "Improvements in galvanic batteries."—Dated July 30, 1875.

2729. Charles Edgar Wetton, of Field House, Harrow, Middlesex, for an invention of "Improvements in magnetic appliances."—Dated August 3, 1875.

2767. Edward Griffith Brewer, of Chancery Lane, London, for an invention of "Improvements in the production of electric light, and in apparatus therefor."—A communication to him from abroad by Stephan Alexandrovitch Kosloff, of St. Petersburg, Russia.—Dated August 5, 1875.

2771. Sir Charles Wheatstone, Knight, of Park Crescent, Regent's Park, Middlesex, for an invention of "Improvements in the mode of and apparatus for applying electricity to give telegraphic signals and work telegraphic relays."—Dated August 5, 1875.

GRANTS OF PROVISIONAL PROTECTION FOR SIX MONTHS.

2518. To Sir Samuel Canning, Knight, civil engineer, of Great Winchester Street Buildings, London, and Henry Francis Joel, engineer, of Lavender Grove, Dalston, Middlesex, for the invention of "Improvements in pneumatic signalling or communicating apparatus, and in the mode of and apparatus for testing the transmitting tubes for the same, applicable also to the testing of gas and other pipes or tubes."

2564. To Theophile Adolphe Hequet, engineer, of Paris [France], for the invention of "Improvements in electro-magnets."

2633. To Francis Robert Lucas, of 38, Old Broad Street, London, for the invention of "Improvements in submarine cables."

PATENTS WHICH HAVE BECOME VOID.

2213. William Ford Stanley, of 5, Great Turnstile, Holborn, Middlesex, for an invention of "Improvements in electrical apparatus."—Dated July 25, 1872.

2240. Charles Ernesto Spagnoletti, telegraph engineer, of Paddington, Middlesex, for an invention of "Improvements in tell-tale indicating and registering arrangements and mechanism."—Dated July 27, 1872.

2260. Charles Fairholme, of 15, George Street, Hanover Square, Middlesex, for an invention of "Improvements in the means of effecting electrical communication in railway trains, and apparatus therefor."—Dated July 29, 1872.

LETTERS PATENT FOR INVENTIONS WHICH HAVE BECOME VOID,

BY REASON OF THE NON-PAYMENT OF THE ADDITIONAL STAMP DUTY OF £100, BEFORE THE EXPIRATION OF THE SEVENTH YEAR FROM THE DATE OF SUCH PATENTS.

2369. Samuel Manley Martin, of Pinner, Middlesex, and Samuel Alfred Varley, of 66, Roman Road, Holloway, Middlesex, telegraph engineers, for an invention of "Improvements in train intercommunication, parts of which invention are applicable to electro-magnetic and electric telegraph apparatus.—Dated July 28, 1868.

PATENTS GRANTED IN BRITISH COLONIES AND DEPENDENCIES,

CANADA.

4454. Hugh Neilson, of Toronto, Ont., for "Gravity Battery."—5 years. Dated March 3, 1875.

4537. Louis Schwendler, of Calcutta, India, for "Duplex telegraphy."—5 years. Dated March 23, 1875.—*Claim:* 1st, the double-balance method of duplex telegraphy. 2nd, the ratios and the magnitudes of the resistances to be employed in the double-balance method. 3rd, the method of simultaneous adjustment by means of a regulator, and the apparatus designated "regulator." 4th, the method of adjustment by means of an indicator, and the apparatus designated "indicator." 5th, the method of automatic adjustment by means of an operator, and the apparatus designated "operator." 6th, the method of adjusting in the battery branch, and the special apparatus for effecting it. 7th, the constant resistance-key, with spring and double battery. 8th, the use of any cable in connection with the *d* branch of the arrangement. 9th, the application of a shunt for the receiving instrument in the *b* branch, and the use of such a receiving instrument in the *b* branch.

PATENTS GRANTED IN FOREIGN STATES.

BELGIUM.

37,383. R. K. Boyle, for "Improvements in electro-magnetic telegraphs with induction-currents, and in the apparatus for producing those currents."—Dated July 2, 1875.

4608. Thomas E. Edison, of Newark, N.J., U.S., for "A quadruplex telegraph."—5 years. Dated April 10, 1875.—*Claim:* 1st, the combination in telegraphic circuits of keys that produce a rise or fall of the electrical tension keys, that change the polarity of the current connected with the line, receiving magnets operated by rise and fall of electrical tension, and polarised magnets that operate by change of polarity of the electrical current. 2nd, the combination with electro-magnets, operated by rise and fall of electrical tension of relay circuits, batteries, and electro-magnetic receiving-instruments or sounders. 3rd, the combination with a polarised relay magnet operated in the telegraphic circuit by change of polarity of the current of relay circuits, batteries, and receiving electro-magnets or sounders. 4th, a telegraph arranged to operate by rise and fall of tension and change of polarity of the electrical currents, the use of condensers, rheostats, or induction-coils to neutralise the static charges and discharges. 5th, the arrangement of circuit connection to relay quadruplex or duplex telegraphic messages. 6th, the arrangements of the telegraphic instruments and circuits for duplex and quadruplex transmission.

4616. Charles Clamond, of Paris, France, for "Improvements on thermo-electric piles."—5 years. Dated April 10, 1875.—*Claim*: 1st, sealing or fitting negative plates of thermo-electric piles. 2nd, casting bars of thermo-electric piles in moulds previously heated almost to the point of fusion of the thermo-electric material from which they are to be made. 3rd, heating thermo-electric piles by gas, especiall y those piles or generators in wh ch bars are built up and arranged between two ring plates united by bolted cross-bars. 4th, the construction and employment of circular thermo-electric generators or piles.

ABSTRACTS OF SPECIFICATIONS.

Improvements in electric signalling apparatus. Benjamin Pryor Stockman, civil engineer, 3, Poets' Corner, Westminster. January 22, 1875.—No. 255. This Specification describes a construction of "commutating key" for sending two or more currents through the line each time the key is depressed, and also a receiving instrument in which a loop or single line of gold, platinum, or other non-magnetic metal is used.

Improvements in electric apparatus. Frank Wirth, of the firm of Wirth and Co., patent agency, Frankfort-on-the-Main, Germany. (A communication from Josef Leiter, manufacturer, Vienna, Austria.) January 26, 1875.—No. 296. All batteries hitherto constructed, especially those which have to be transported, have the disadvantage that when they were charged they could not be hermetically closed, and that when the elements had to be lifted out a complicate mechanism was necessary. If such batteries were to be transported for some distance the several parts of them and the acid had to be packed in separate vessels. Elements that remain filled during the time when they are not employed consume metals and acids uselessly, and are readily spoiled. All these disadvantages are avoided with my apparatus.

Improvements in electric telegraph apparatus for train-signalling and working the traffic on railways upon the block or space system, parts of which apparatus are applicable to and for other purposes. Richard Robert Harper, electric telegraph engineer, 19, Salisbury Street, Adelphi, W.C. January 28, 1875.—No. 336. Fitting or applying a guard with a screen plate in front of the exterior of the case, so as to prevent both plungers, keys, or tappers being moved or operated upon at the same time. Also arranging the combination of a permanent magnet with the two poles or terminals beneath or in a different plane to the poles or terminals of an electro-magnet, of which one is on each side and above the permanent magnet, and so placing a compound armature and needle mounted on the same spindle between them that the current, on traversing the electro-magnet, magnetises the compound and curved armature, which is attracted by the one pole, and the other pole repels the other end of the same armature, whilst the pole of the electro-magnet which is repelling the said armature is at the same time attracting the needle, and the reverse pole of the electro-magnet at the same time repels it. Also in a novel arrangement of key and apparatus, whereby the instrument is kept free from the disturbing effects of lightning, earth-currents, line-contacts, and such like disturbing causes, by a peculiar arrangement of spring contact-pieces and insulation. And to the bell, gong, or relay, there is applied two springs, which are acted upon and brought in metallic contact as described. By this arrangement any error is prevented if the receiver by any accident uses both the sending and receiving portions of the apparatus at the same time. Also an arrangement of interlocking gear for preventing the signals for working traffic between branch lines and the main line (or *vice versâ*), or, on single lines of railway, to prevent two trains being taken or admitted on to one section of the line at the same time. This is effected by the use of a double-ended lever-arm or "yoke" fitted on the bottom of the case connected to the battery or earth as between two or more instruments, so as to insure the signals being consonant and harmonious, and in no case conflicting or contradictory. This "yoke" is alternately acted upon by one or other of the plungers, tappers, or keys, and cannot be acted upon by both of them at the same time. The battery and battery-cells for working such instruments are made by forming the plates of silver, with vertical corrugations, to give them structural stability, to prevent their buckling or bulging out, and prevent their coming in contact with the zinc plates. The cells are formed with small pockets on each side at the bottom, for receiving a limited quantity of mercury and the ends of the zinc plates dipped thereinto.

United States.

Duplex Telegraphs.—M. Gally, Rochester, N.Y., February 9, 1875.—1. The combination, with the main line, of a branch containing both the receiving instrument and a magnetic key or switch for connecting main line with battery, or for breaking its direct connection with ground, substantially as specified.—2. The combination, with circuit D, having a magnetic switch therein, of circuit A A', the one being open while the other is closed, and *vice versa*.—3. The combination, with the main line, of sub-line A' and switch *f*, for cutting out the main battery when not in use for transmitting, substantially as specified.—4. A receiving magnet, provided with ordinary electro-magnet or magnets, and an additional magnet or magnets, all acting upon the same armature-lever for equalising its stroke under different conditions of currents, substantially as specified.—5. A compound electro-magnet, consisting of a number of cores and helices, a part of which are stationary, the armature being adjusted to them by means of a spring, the others being in themselves adjustable, to be moved to or from the armature, substantially as specified.—6. An armature having magnetic extremes and non-magnetic centre, the extremes to be affected by electro-magnets as a polarised armature, and the centre as a common armature, substantially as specified.—7. The combination, with the main line passing through one or more of the magnets of the receiver of the compensating circuit passing through the same magnet or magnets, and also through another magnet or magnets not affected by the main line current, but all acting upon the same armature lever, substantially as specified.—8. The combination, with a main line and its battery, of one or more circuits, each having a section of union with the main line, and an independent battery maintaining intact its own circuit current, the magnetic or neutral condition of each section of union changing with any change of the direction of the main current, substantially as specified.—9. The method of reducing the resistance of a wire or helix to a given current, by passing through it, in whole or in part, the current of another circuit or circuits.

Electric Motors.—Charles J. B. Gaume, Williamsburgh, N.Y., May 1, 1875.—The frame or box armature E, made with four, more or less, plain or concaved sides, having half-round or square enlargements formed upon their outer or inner surfaces, substantially as herein shown and described.

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LONDON: BOY COURT, LUDGATE HILL, E.C.

London: Printed and Published by the Proprietor, WILLIAM CROOKES, at the Office, Boy Court, Ludgate Hill, E.C.
August 12, 1875.

THE

ELECTRICAL NEWS

AND

Edited by Wm. Crookes, F.R.S., &c.] **TELEGRAPHIC REPORTER.** [*Registered for Transmission Abroad.*

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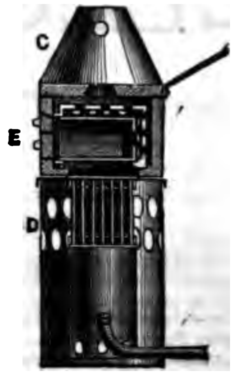

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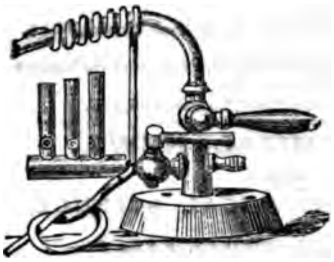

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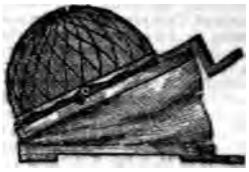

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VOL. I. No. 8.

A NEW METHOD FOR THE DETERMINATION OF A LOSS OF INSULATION IN SUBMARINE CABLES.*

By EMILE LACOINE,
Director of Telegraphs, Constantinople.

THE methods hitherto employed are not very precise, especially when—the cable not being broken—the loss is such as to still allow commmunications between extreme stations. Polarisation produced at the fault vitiates also the results obtained, and it is not possible to keep into account the influence of natural currents circulating into the cable. Those who have had to determine a fault of this nature know all these difficulties.

The method herewith introduced is a combination of that published by the author, "On the Determination of Voltaic Constants" (see *Journal Télégraphique* of Berne, January 25, 1873), and of the proceedings indicated by Latimer Clark in his paper "On a Voltaic Standard of Electromotive Force" (see *Proceedings of the Royal Society*, vol. xx., p. 444, 1872). The influence of polarisation at the fault is entirely avoided, as well as that due to the presence of natural currents. The distance to the fault is obtained without making any comparison to previous tests, and there is no supposition to make as regards the temperature of the cable, and therefore its conductibility, at the time of the experiments. This method is likewise independent from variations which may take place in the electromotive force or resistance of the batteries employed.

It therefore seems to combine all conditions of accuracy, far surpassing those that can be obtained by other methods for the same case, which is, however, one of the most difficult.

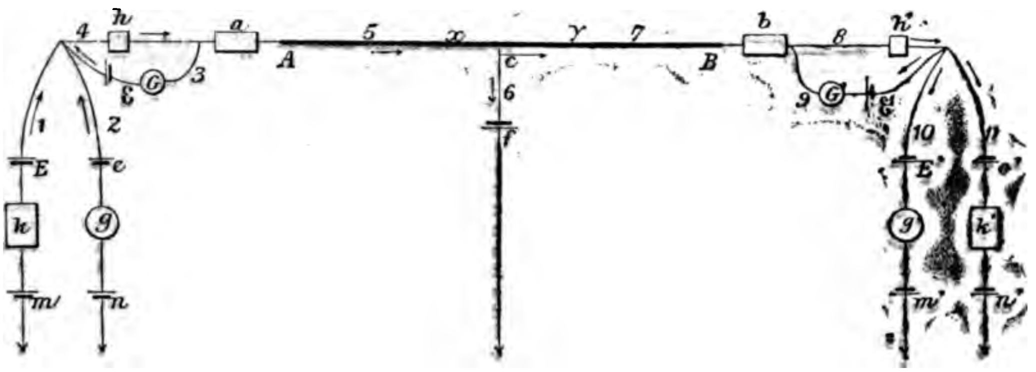
We shall first explain this method theoretically, then we shall examine the means to be employed for its practical application. It is sufficient for the present to observe that experiments are made simultaneously at both ends of the cable.

A B is the cable and C the fault.

K, *h*, *a* and K', *h'*, *b* are resistances, K and K' being variable and arbitrarily graduated, or even not graduated at all; *h* and *h'* arranged so as to allow taking at will a determined and previously fixed resistance, or its double; *a* and *b*, two slide resistance-boxes, graduated in the same units.

G *g* and G' *g'* are Thomson's galvanometers.

* Communicated by the Author.



ε and ε' batteries formed, each of them, with a standard cell of Latimer Clark's, and therefore equal.

e and *e'* batteries also formed with elements of Latimer Clark's type.

E and E' batteries of any kind, but having a total electromotive force superior to that of *e* and *e'*.

Batteries E and E' are the only ones producing current and work.

Finally, *m n* and *m' n'* represent the natural electromotive forces which may develop themselves in and act on the cable.

The batteries being arranged as shown by the above diagram,—viz., in such a way that currents leaving ε and ε' add themselves in the cable, and are opposed to the corresponding currents starting from E and E' and from ε and ε',—we have, according to Kirchhoff's law, the following relations, naming *i* the intensities and *r* the resistances corresponding to each part of the circuit:—

$$i_1+i_2+i_3=i_4 \qquad i_2 r_2+i_4 r_4+i_5 r_5+i_6 r_6=n+e+f$$
$$i_3+i_5=i_4 \qquad i_3 r_3+i_4 r_4=\varepsilon$$
$$i_6+i_7=i_5$$
$$i_7+i_9=i_8 \qquad i_{10} r_{10}+i_8 r_8+i_7 r_7-i_6 r_6=n'+e'-f$$
$$i_9+i_{10}+i_{11}=i_8 \qquad i_8 r_8+i_9 r_9=\varepsilon'.$$

In order that no polarisation should take place in C, the current there should be *nil*, and—

$$i_6=0,$$

wherefrom—

$$i_5=i_7.$$

To avoid polarisation we must therefore arrange so that there are equal intensities in A and B. ε and ε' should therefore be made equal, which is already the case; and if we introduce in *h* and *h'* two resistances conveniently selected, modifying at the same time *a* and *b* so as to bring to zero the needles of galvanometers G and G', we shall have—

$$i_3=0 \quad \text{and} \quad i_9=0.$$

Moreover, we may eliminate the values of resistances in batteries E and E', thus doing away at the same time with the effect of variability in their electromotive forces, by modifying K and K' so as to bring also to zero the needles of galvanometers *g* and *g'*. We have thus—

$$i_2=0 \quad \text{and} \quad i_{10}=0.$$

So that all the preceding relations become—

$$i_1=i_4=i_5=i_7=i_8=i_{11}=\mathrm{I}$$
$$\begin{cases}\mathrm{I}\,(r_4+r_5)=n+e+f \\ \mathrm{I}\,.\,r_4=\varepsilon\end{cases} \qquad \begin{cases}\mathrm{I}\,(r_8+r_7)=n'+e'-f \\ \mathrm{I}\,.\,r_8=\varepsilon.\end{cases}$$

To obtain equal intensities we must therefore make $r_4=r_8$,—that is to say, we must have $h=h'$, as it is evident that $r_4=h$.

From the above equations we obtain—

$$\frac{n+e+f}{h+r_5}=\mathrm{I} \qquad \frac{n'+e'-f}{h'+r_7}=\mathrm{I}.$$

After having realised these conditions, the same operation is repeated by reducing the circulating current to half its value. It is sufficient in that case to double h, and to vary the resistances a and b until the galvanometers return to zero. Then we have again—

$$\frac{n+e+f}{2h+R_5}=\frac{1}{2} \quad \text{and} \quad \frac{n'+e'-f}{2h+R_7}=\frac{1}{2}.$$

From these four relations we obtain the two following ones:—

$$2r_5=R_5 \quad \text{and} \quad 2r_7=R_7.$$

We have, on the other hand,—

$$r_5=a+x \qquad r_7=b+y$$
$$R_5=A+y \qquad R_7=B+y,$$

A and B being the new values of resistances in a and b. Therefore—

$$x=A-2a \quad \text{and} \quad y=B-2b.$$

If it has been operated so as to make the experiments in quick succession, thus avoiding the variations which might arise in the natural electromotive forces n, n', and f, the result obtained will be altogether independent of the acting batteries, of polarisation at the fault and of the presence of natural currents.

Let l express the length of the cable, and d the distance to the fault on side A C; we have evidently—

$$\frac{l-d}{d}=\frac{y}{x},$$

wherefrom we find for the required distance—

$$d=\frac{l(A-2a)}{A+B-2(a+b)}.$$

Practical Operation.

The series of manipulation described above may appear at first tiresome and difficult, but it is not so, especially if the distance to the fault is already known approximately, and if we make $e=e'$, as in that case we may determine very closely the values to give to resistances a and b in both successive experiments, and then we shall easily and quickly bring to zero the needles of both galvanometers G and G′.

At each end of the cable there should be an electrician and his assistant. The latter will manipulate resistance K by sliding it gently either right or left until the needle of galvanometer g comes to zero.

The electrician acts on resistance a, after having taken for h a convenient quantity previously determined; he thus tries to maintain at zero the needle of galvanometer G.

To proceed with experiments, when everything has been previously concerted, when h is determined and g at zero, send both currents; then galvanometers G and G′ deviate, and resistances a and b have to be gently altered until the two galvanometers return to zero.

Suppose that the electrician placed in G be in charge of the whole operation,—as long as his galvanometer stands at zero, he knows that G′ is also at zero, and therefore that resistance b remains unaltered.

This done, he alters h in $2h$, which moves the needles in both galvanometers, and serves as a signal for G′, who also alters h' into $2h'$, and on each side galvanometers are brought to zero in the same way as before.

After these experiments, the numbers found on the rheostats at the nearest time of the alteration of h in $2h$ are exchanged between both electricians.

These operations can be repeated several times in order to obtain means.

If it is desired to find the resistance of the fault, it will be easy to find it out from the distance, by one of the methods hitherto known.

Constantinople, May 5, 1875.

HISTORY OF MAGNETO-INDUCTION MACHINES WITH UNINTERRUPTED CURRENT OF INVARIABLE DIRECTION.*

These machines are finding a continually wider application for various industrial and scientific purposes, and prove highly advantageous and convenient as a substitute for galvanic batteries. A sketch, therefore, of the history of their development will not be without interest.

Those induction machines, in which a copper body is made to turn between electro-magnetic poles, and also the so-called unipolar induction apparatus, in which either one pole of an electro-magnet turns constantly about a fixed conductor, or the half magnet, turning about its own axis, itself forms a part of the conductor, may be fitly here left out of account, for they give too weak a current (though an uninterrupted one), and would only be made for scientific experiment.

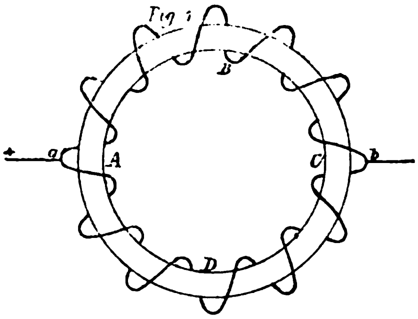
More powerful currents of unvarying direction and as unvarying strength as possible, it has been sought to obtain, by so connecting two or several ordinary magneto-induction machines, that the times of greatest current strength of one, produced by the one magnet, coincided with the least current strength of the other. This was very well accomplished in a machine which Siemens and Halske, of Berlin, sent to the London Exhibition in 1851. In this machine, a round iron disc, or *plate*, supported by a ball and socket joint, turns about this joint, in that peculiar manner in which an ordinary plate whirled on its edge moves shortly before it finally falls; and it does so on magnet poles arranged in circuit. The circuit plane lies somewhat lower than the ball and socket, and the polar surfaces are cut according to a pretty obtuse conical surface, as the under surface of the plate also forms the mantle of such a cone. Vertically to the upper side of the plate, in its middle over the ball and socket, stands a metallic arm, which, therefore, as the plate moves, describes a conical surface; its upper end catches an arm fitted on the axis of a commutator, and so puts this axis in rotation. The rolling plate thus produces in proper order, the closing and opening of contacts, by which the current of a galvanic battery is always sent through the one half of the electro-magnets in the circuit, and that always through those electro-magnets which lie between the then place of contact of the plate with the electro-magnets, and the highest position of the plate (in direction of motion). By the electro-magnets the plate is itself magnetically induced; but at the same time also, it is maintained in its progressive motion through the attraction of it by the electro-magnets. Now each electro-magnet has a second coil; so that an induction current must occur in this, at each appearance and disappearance of the current in the first coil. These second coils of all the electro-magnets are connected into a whole returning on itself; and at the connecting line of two neighbouring coils the wire is brought loopwise to the commutator. Although the induction currents produced in all the electro-magnets round which the galvanic current flows are due to production of magnetism, and the induction currents in the electro-magnets untraversed by the current are due to disappearance of magnetism and opposite in direction to the former, they are yet, by means of the commutator, led away as an uninterrupted current of unvarying direction to the common connecting wires. This arrangement and commutation has much similarity to Pacinotti's (to be noticed presently), and in both there is the peculiar partition of the circuit into two branches. These machines of Siemens and Halske were designed to furnish, with few elements, an electric current of high potential, which could be employed in working of long telegraph lines. Thus the machine was used in direct telegraphy from Leipsic to Vienna through Munich. During the London Exhibition, too, the machine was used in working of telegraphs and other apparatus; but

* Abstract of recent paper by Prof. Zetzsche. Communicated by the Author.

neither was its arrangement anywhere described nor the machine further improved. The peculiar plate notion, however, Dr. Werner Siemens has again adopted in a new dynamo-electric machine.

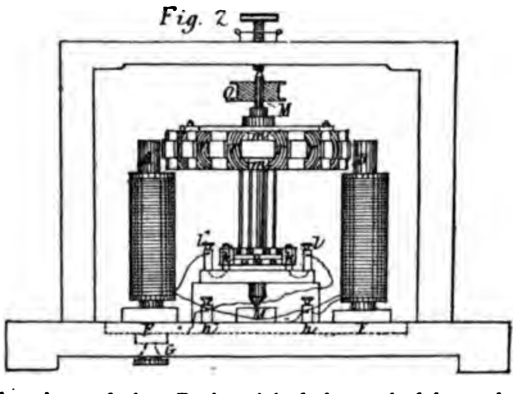
As the first magneto-induction machine with uninterrupted current of unvarying direction and strength after that just noticed, we must regard the one constructed by Prof. Antonio Pacinotti for the physical technological cabinet of the University of Pisa. A description and drawing of this machine were published on March 3, 1865, in *Nuovo Cimento* (being the June number for 1864); we make from it the following extracts:—

"If, as shown in Fig. 1, a ring of soft iron, A B C D, be

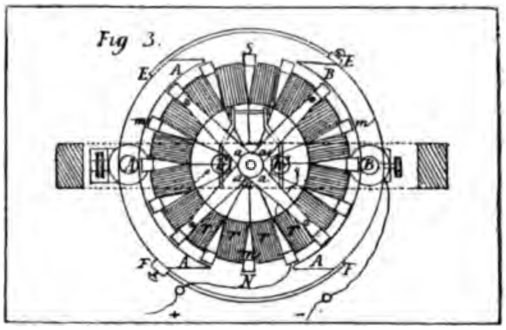


wound round with silk-covered copper wire in one position, and unvarying direction, and the two wire ends be soldered together where they meet; if, then, the poles of a galvanic battery be connected to two (uncovered) points of the wire, *a* and *b*, distant as far as possible from each other, the electric current will go in two branches from one of these points to the other, and, in virtue of the direction of current in the two branches, the iron ring will be so magnetised that its poles are situated where the current wires come to it, viz., at A and C. Hence the straight line passing through these two poles will be the magnetic axis. By changing the place of junction of the battery wires, we may give the poles any position across through the iron ring of the electro-magnet, and therefore Pacinotti names the latter a 'transversal electro-magnet' (*elettro calamita transversale*). The two halves of the electro-magnet lying one on either side of the straight line A C (in Pacinotti's machine a diameter), may be considered as two bent electro-magnets, with like poles applied to each other.

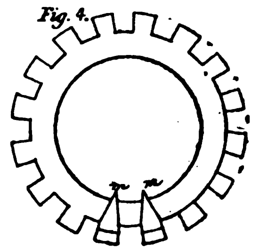
"To construct from this transversal electro-magnet the electro-magnetic machine, shown in Fig. 2 and 3 in



elevation and plan, Pacinotti had the toothed iron wheel represented in Fig. 4, and having sixteen equal teeth, fixed by means of four brass arms *a*, on an axis M M, and wound round with silk-covered copper wire, so that by the teeth and the attached wooden prisms *m*, the whole system was divided into sixteen well insulated bobbins *r r*; each bobbin had nine layers, and all the bobbins were wound in the same direction. Each wire going from one bobbin to its neighbour, was fixed loop-wise to the piece of wood between two bobbins, and passed through suitable holes in a wooden disc fixed on the axis M M, down the axis to a commutator *o*, also fitted on the axis. In the outer surface of the wooden disc of this commutator were inserted, in two rows, and



opposite each other, eight pieces of brass, which projected a little beyond the wood, but were separated from each other by the piece of wood between; each of these was soldered to one of those loops. Thus, when the two metallic rollers *k k'*, which were in contact with the pieces of brass, were connected with the two poles of a battery, the current was conducted from the brass pieces in contact with the rollers, in two branches, through the entire system of coils; the magnetic poles in the iron ring



appeared at N and S,* were attracted and repelled by the poles A and B of a fixed electro-magnet, and the transversal electro-magnet began to go round on its axis, its poles, however, still retaining the position N S. The position of the arms of the electro-magnet A B could be regulated by the screw G. By means of the binding screws *h h' l l'*, the same current could be sent round A B and through the bobbins *r r*.

"Pacinotti found it useful to furnish the poles of the fixed electro-magnet with shoes, A A A and B B B (omitted in Fig. 3), extending round the transversal electro-magnet more than ⅓rd of its circumference, and joined to each other by brass connections.

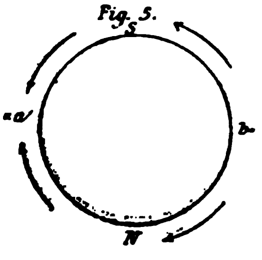
"By means of the cord-pulley Q (Fig. 2) he tried to determine the power of his machine by raising a weight, and found an expenditure of 33 to 36 m.grms. zinc for about 1 mk. work done. He hopes a more carefully constructed machine will give better work, and notes the advantages of his machine over previous ones.

"Pacinotti now shows that this electro-magnetic machine changes into a *magneto-electric machine with uninterrupted current*, if the electro-magnet A B be replaced by a permanent magnet, and the transversal electro-magnet be put in rotation, and remarks that in the moved transversal electro-magnet, through induction, the poles N and S (Fig. 5) at the end points of a diameter,

* It is understood that the connection of the brass pieces of the commutator with the loops between the bobbins was arranged in the way corresponding to this.

would occur opposite the poles of the fixed magnet, that these poles must always have an unvarying position, even when the transversal electro-magnet is turned, and that therefore one might conceive that the coils move round over the circular magnet while this is at rest. In the motion of a bobbin from north pole N to south pole S, the induced current will have the same direction till the bobbin is at the middle *a* between N and S; between *a* and S the direction of current will be reversed, and will continue thus in the motion from S to the middle *b*

Fig. 5.



between S and N, and in passing from *b* towards N will resume its former direction. The currents furnished by the different bobbins will thus be added to each other, and may be most conveniently collected and led away at *a* and *b*; the current collector must thus be applied to the commutator at right angles to the magnetic axis of the electro-magnet; applied in the axis itself, on the other hand, it could not receive any current. The direction of current will be changed with changes of direction of rotation.

(To be continued).

AN ELECTRIC PHOTOMETER.

WHOEVER (says Dr. Werner Siemens, in a paper recently read to the Verein für Gewerbfleiss) has gone thoroughly into the subject of Photometry, will have come to the conviction that it is still at a very low stage of development. It has not yet been once fixed what, exactly, we have to measure. Every solid body, we know, raised to high temperatures, emits light and heat-rays in all directions. According to the new theory it is ether waves, of all possible wave-lengths, which go out from the hot body. A portion of these waves excites in our retina, when it strikes it, the sensation of light. If short and long ether waves are in a proportion to each other, like that in which the sun or other very highly heated body emits them, we call the sensation of light we receive from them "white light." When, however, only light waves of a certain wave-length are admitted to our eye, our sensation of light is altered, and we name the light red, yellow, blue, violet, according to the wave-length of the rays admitted. The prism, it is known, is a means by which the rays of a white bundle of light may be separated according to the wave-length. Since the impressions of the red, yellow, blue light are quite different on us, it is evidently quite impossible to compare together the intensities of such different sensations. The photometers hitherto made, however, are all on the principle of so regulating the action of the two light-sources to be compared, on an illuminated object, that the latter seems to our eye illuminated to an equal degree by the two sources. This method is best carried out by Bunsen's photometer, which is based on the fact that an oil-spot on a piece of white paper is no longer visible, when it is illuminated on both sides equally, strongly with white light. This is pretty accurate so long as both light sources send out white light, or at least light of the same colour. If the colours are different the spot does not disappear, and there is no means of comparison. There is, of course, still another criterion of light-strength, and it is properly the only correct one. We require light for the perception of objects, and that light is for us the best or brightest which enables us most distinctly to see the objects. One might hereupon construct a photometer quite independent of colour, by so regulating, in any way (*e.g.*, by diminishing the light-receiving surface of a lens), the strength of the two light sources, that the same object might be equally distinctly perceived with both. It would appear, however, that the eyes of different men are unequally receptive for differently coloured light, and are also soon fatigued, so that this otherwise rational method of light measurement, also, cannot yield constant results.

I have endeavoured to utilise electricity (that force which so often helps us when other forces fail), in measurement of light.

It is known that selenium—a substance standing on the boundary of the metals and metalloids, and possessing many remarkable physical properties—has two properties, which would seem to render it peculiarly suitable for the object in view. When selenium that has been quickly cooled—amorphous selenium—is heated to a temperature of 80° to 100°, the mass becomes crystalline, under development of heat, and a conductor of electricity, whereas in the amorphous state it is an insulator. Now, this crystalline selenium has the remarkable property—discovered and described by the English Lieut. Sale—of conducting electricity better when it is illuminated than when it is in darkness. Sale further found that the increase of the conductivity increases with the strength of the illumination, so that—in remarkable agreement with the retina of the eye—it is most strongly influenced by those parts of the spectrum which most affect the eye.

These remarkable properties I sought to turn to account in photometry. The initial difficulties—consisting partly in the small conductivity of crystalline selenium, its inconstancy, and the very weak and variable action of the light, partly in the disturbing influence of heat-rays—I succeeded in removing, inasmuch as, by long heating of amorphous selenium nearly to its melting-point, or by crystallising out from the slowly cooled molten mass, I prepared a modification of the crystallised selenium, which conducts much better, is much more influenced by light, is not essentially affected by heat-rays, and retains its properties pretty constant. It is especially notable that its conductivity *decreases* on heating, as in the case of metals, whereas in the other the conductivity increases, as in the case of conducting metalloids and electrolytes. By filling up the interval of two small flat spirals of wire with such coarsely crystalline selenium between two leaves of mica, I have succeeded in producing a photometric apparatus which—with a Daniell's cell or a small thermo-electric electromotor—gives sufficiently strong currents for one to be able to compare, by measurement of them, even very weak intensities of light with sufficient exactness.

The apparatus which I show you here is such an electric photometer. At the bottom of a small tube, which can be rotated, is some of the selenium preparation as described. The ends of the two spiral wires are connected with each other through a Daniell cell and the wire of a galvanometer. The needle is thus deflected. If I remove the cover of the tube, and admit the light of a gas-flame, whose strength I would measure, to the selenium disc, the conductivity of the disc increases proportionally to the strength of the light; so the deflection of the needle becomes greater. If I now turn the tube so that it is directed to a normal candle, instead of to the flame to be measured, and regulate the distance of this normal candle so that the deflection of the needle becomes and remains the same when the selenium is alternately illuminated by the flame to be measured and the normal candle, the light action is the same from both, and the light strengths are accordingly in inverse proportion to their distance from the selenium plate.

This instrument can be made with any degree of sensibility desired, and I hope that a practically serviceable apparatus may be developed from it. It will probably

also become possible thus to indicate light strength graphically in a continuous matter, but many experiments are yet required in order to acquire a sufficient basis for this.

ON THE

VIBRATIONS OF MIRROR INSTRUMENTS.

MR. GRAVES recently called the attention of the Society of Telegraph Engineers to the vibrations of the *spot* thrown by the mirror instruments in use on the Atlantic cables. In the discussion which followed the reading of Mr. Graves's paper, Mr. Preece attributed these vibrations to the polarisation of the earth-plates, whence proceeded opposite and weak currents sufficient to cause the needle to oscillate in very small arcs.

The same phenomenon was observed last December, at Marseilles, on the Algiers cable, and a series of experiments were instituted by M. Wunschendorff, who states that the alternation of positive and negative currents seems to exclude the possibility of earth-plates becoming polarised in a sensible manner. Besides, the vibrations (of an intermittent character) were observed at Marseilles for the first time since the cable was laid, twelve years ago; they often appeared when no current had been sent into the cable for one or two hours, and persisted during a variable time.

Experiments were made at the Prado cable-house. An underground line cased in iron wires, and about 5 kilometres long, led from the cable to the Marseilles telegraph station; and "earth" for the transmitting and receiving instruments was made through the iron protecting sheath of this underground line. At the Prado cable-house the Barcelona cable likewise emerged, and was continued to Marseilles by an underground line in juxtaposition to the one just referred to.

On the 6th January last M. Wunschendorff inserted in the Algiers cable circuit a mirror-receiver at Prado. The underground line at Marseilles was successively put into direct communication with various "earths":—

(1). The "earth" of the Barcelona cable; being through the sheath of its underground line soldered to the sheath of the cable itself, and through the town gas pipes.

(2). The sheath of the (Algiers cable) underground line from Marseilles to Prado.

(3). The ordinary earth at the Marseilles office.

(4). A strand composed of three new iron wires (4 m.m. diameter) immersed in a well close to the office.

(5). The sheath of the Algiers cable. After each observation the receiving mirror was replaced by a very sensitive static mirror galvanometer, whose movements were considerably amplified.

The results obtained are tabulated as below:—

Order of Experiment.	Earths.	Effects on the Receiving Mirror.	Deflections on Thomson's Galvanometer, Shunt 1/99.
1.	Of the Barcelona cable	No vibrations	50 divisions
2.	Of the Prado underground line	Very feeble vibrations ..	36 divisions
3.	Ordinary earth of the Marseilles office	Vibrations	40 divisions, with kicks of 40 to 60 divisions
4.	New iron strand	Vibrations	A *mean* of 40 divisions, with kicks of 50 divisions to right and left of this position
5.	The sheath of the Algiers cable	No vibratio	55 divisions

The galvanometer's coefficient for Leclanché element being 97 megohms, and the resistance of the Algiers cable 5500 ohms, the electromotive force giving a deflection of 40 divisions (with shunt 1/99) corresponds to about one-third of a Daniell element.

Experiments made on the following days gave analogous results. The galvanometer indicated, in every case, the existence of a current whose strength was sometimes constant, sometimes variable; and the vibrations were infallibly produced when "earth" was through the iron strand, or through the ordinary plate of the Marseilles office. The vibrations of the luminous *spot* can therefore only be attributed to the variations of this current conjointly with the elasticity of the mirror's suspending thread.

The current itself may be attributed to two principal causes:—(1). *Difference of potential between the two points of the earth where the earth-plates are buried*, and whence result the so-called terrestrial currents. In the present state of electrical science, conjectures can only be thrown out as to the primary causes of these terrestrial currents: even the laws of their variations are unknown to us. (2). *Difference of chemical action of the soil upon the earth-plates.* It was proposed to use platinised metallic sheets (as earth-plates) to eliminate the effects probably due to this second cause, but the chief inspector having decided to permanently solder the sheath of the underground line to that of the Algiers cable, and the vibrations disappearing, further experiments were discontinued.

EXPLANATION OF MR. L. SCHWENDLER'S DOUBLE BALANCE METHOD OF DUPLEX TELEGRAPHY.

By W. P. JOHNSTON, Calcutta.

(Concluded from page 77.)

The Key Equation.

14. It now becomes necessary to examine the part played in the arrangement by the resistance w. "*The immediate balance condition*" is, as mentioned before, expressed by the equation—

$$a\,d-g\,f=o,$$

but the resistance f is in circuit only so long as contact 3 of the key exists. On depressing the key—*i.e.*, on making contact 4 and breaking contact 3—the resistance f is replaced by the resistance w and the signalling battery; the battery of course has its internal resistance B, which may be equal to, or less, but must never be greater than f; if equal, no resistance is required in w, for the altered position of the key puts in circuit the battery resistance in place of f, but if the battery resistance be less than f then so much resistance must be unplugged in w as to make—

$$w+\mathrm{B}=f,$$

and this is the "key equation" that must always be rigidly fulfilled, for on it clearly depends the fulfilment of "*the immediate balance condition*."

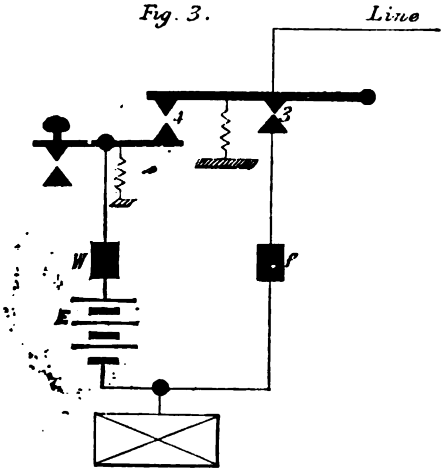
15. In the ordinary signalling keys, between the breaking of contact 3 and the making of contact 4, there is an interval of time during which neither of these contacts exists, and the line becomes insulated, but in duplex working this interval of insulation must obviously be avoided, for were one station to send a signal to the other during this interval it would be partly lost, owing to the line being to earth by one branch only, the other being insulated. A key of peculiar construction, a "*constant resistance key*" (Fig. 3), avoids this. Contact 3 cannot be broken before contact 4 is made, and consequently the line can never become insulated. It is true that these two contacts must exist together for a short time, and that the

resistance from the key to earth is then neither f nor W+B, but—

$$\frac{f}{2} \text{ or } \frac{W+B}{2},$$

but this time is so exceedingly short that its existence causes no disturbance whatsoever in the received signals,

Fig. 3.



and may be altogether neglected so long as the signalling speed does not exceed a certain limit.

Condensers.

16. The condensers are composed of sheets of tin-foil insulated from one another by sheets of paper soaked in paraffin. On receiving a charge of electricity these sheets of tin-foil act inductively on one another, and a large amount of electricity is accumulated. One end of the condensers is connected to earth, the other end being connected to the resistance-box d, and consequently, on depressing the signalling key, that portion of the current passing through d charges the condensers; the charge increases so long as the key is depressed, and when released this charge escapes to earth through b and g.

17. All telegraph lines act as condensers, and when signalling on long and highly-insulated lines, after each signal sent, a discharge (return beat) from the line that passes through the receiving instrument is received. In single telegraphy this discharge is carried direct to earth by means of a "*discharging relay*," the tongue of which makes a momentary contact with the earth between the making and breaking of the two key contacts. This phenomenon of discharge is best explained as follows:—On depressing the key and putting the copper pole of the battery to line, the potential of the line is raised above that of the earth, and on releasing the key a discharge occurs from the line to restore equilibrium, or to place the line and the earth at the same potential again.

18. Now as the line and the condensers are connected to the opposite ends of the coils of the receiving instrument, the charges and discharges from them flow in contrary directions through g, and the flow of these transient currents in opposite directions will be equal so long as they stand in the fixed proportion $\frac{a}{b}$.

19. The capacity of a line is a variable quantity depending on the insulation of the line—the higher its insulation the greater its capacity; so changes of weather necessitate a change in the capacity of the condensers, and by means of a commutator attached to each duplex instrument the necessary changes can easily be effected.

External Duplex Indicator.

20. It will be easily understood that when balancing for "*permanent current*," and for "*charge* and *discharge*," the relays will cease to close the local circuit when these conditions have only been approximately arrived at, and that to obtain absolute balance a far more sensitive guide is required; for this purpose Mr. Schwendler has constructed an "*External Duplex Indicator*," composed of a small magnet finely pivoted, and the position of its pointer with respect to zero shows the attainment of balance. This little instrument is placed above the relay in the most sensitive position.

Actual Duplex Working.

21. Suppose both stations to have balance for "*permanent current*," and also for "*charge* and *discharge*," the line to have no appreciable leakage, and the same pole of the battery to be connected to earth at either station, then—so long as the keys are not depressed simultaneously—the signals are produced as in ordinary telegraphy, with the exception that the receiving instrument of the sending station is always in circuit, but remains entirely unaffected by the sent current of that station, the distant relay only being worked.

22. When both stations depress their keys simultaneously, the line being supposed to have no appreciable leakage, part of the current from Station I. arrives at point 1, and part of the current from Station II. arrives at point 2, and these currents—being equal and opposite—neutralise each other, and *no* current goes out to line from either station,—*i.e.*, the current from Station I. works the relay of Station I., and the current from Station II. works the relay of Station II., or, in other words, as each station wants to work the distant relay at the same moment, this result is equally obtained by each station working its own relay.

23. When, however, the line has appreciable leakage, and the resultant fault is nearer to one station than to the other, the currents arriving at points 1 and 2 (the keys being depressed simultaneously) are not equal, and the difference between them flows out into the line in a certain direction,—say, for instance, towards Station I., when the relay of Station I. is worked by the current of that station plus the current in the line, and the relay at Station II. is worked by the current of that station minus the current in the line.

24. When the line has no appreciable leakage the single and the duplex signals are obviously made by equal currents, and the same is the case when the line has appreciable leakage, on account of balance being always rigidly fulfilled at both stations,—*i.e.*, that though for different conditions of the line the currents are not the same, yet for each particular condition of the line the single and the duplex signals are invariably equal and regular.

25. So long as L—the measured conduction resistance of the line—does not alter, the most perfect working will be experienced, but L is by no means a constant quantity, and though in this "*Double-Balance Method*" the variations in it have the least possible effect on the received signals, yet these variations, if exceeding a certain limit, will cause the received signals either to stick or to fail.

26. With each duplex arrangement a board with the following directions on it is issued:—"*Beats lost increase b*," "*Beats stick decrease b*." When the received signals are lost, a decrease in the conduction resistance (L) of the line has occurred, that causes the sent current to oppose the line current, the condition $a\,d = b(L+\rho)$ is no longer fulfilled, for the current passing through b is greater than the current passing through a, and the difference between the two currents passes through g in the opposite direction to the line current, and causes a loss of signals, and it becomes necessary to increase the resistance in b till the condition $a\,d = b\,(L+\rho)$ is again fulfilled, when perfect signals will be again received. When the received signals stick, an increase in L has occurred that causes the sent current to help the line current, the current passing through a is greater than the current passing through b, and the difference between the two currents passes through g in the same direction as the line current, and causes the received signals to stick, and it becomes necessary to de-

crease b till the condition $ad=b\,(L+\rho)$ is again fulfilled, when perfect signals will be again received.

27. The adjustment in the b branch is not made by the comparatively slow method of withdrawing or inserting plugs, but by means of a contact sliding over equal increments of resistance fixed in a circular box. Moving the slide in one direction increases b, and moving it in the contrary direction decreases b, and this adjustment is quite as simple as turning the micrometer screw of an ordinary polarised relay.

Batteries.

28. For duplex working about four times the battery power employed for single working is required, for the current—from Station I. for instance—first divides at the point x, and subsequently divides again at the point z. The key equation—

$$w+B=f$$

should be controlled once or twice a week by accurately measuring the internal resistance of the battery, and then unplugging in W that amount of resistance necessary to fulfil the key equation. The cells should be very carefully prepared, the same amount of sawdust by weight should be placed in each one, the rims of the jars should be paraffined, and the battery stands should be carefully insulated from the ground.

Control of the Duplex Instrument.

29. Tests of the several resistances for constancy, and of the condensers for insulation and capacity, should be made and recorded periodically.

Routine of Work.

30. On commencing the day's work, and after both stations have obtained balance for "*permanent* and *transient current*," by means of their duplex indicators, Station I., for instance, signals to Station II. the word "*balance*;" Station II. then sends attacks, and Station I. adjusts its relay, by means of the micrometer screw for ordinary single signals, and then sends attacks to Station II. to enable it also to adjust relay for single signals. When this is done, adjustment by means of the micrometer screws ceases entirely, and both stations send attacks simultaneously, and increase or decrease—as may be found necessary—the resistance in the b branch, till perfect duplex signals are received. During the transmission of messages any adjustment that becomes necessary on account of variations in the line is confined solely to the b branch. Corrections and repetitions are obtained as follows:—The receiving signaller, on finishing a message, marks with a cross or underlines the words that he wants repeated, and places the message by the side of the sending signaller, who, after finishing what may be in course of transmission, calls for the required repetitions. In like manner the receiving signaller, who must have the sent messages near him, marks with a cross those words repetition of which is called for, and hands the message to the sending signaller, who gives the repetitions; consequently there is no interruption to traffic—messages and calls for repetition follow one another continuously.

Abbreviations to be used when calling for Corrections, Repetitions, &c.

FULL SENTENCES.		ABBREVIATIONS.		
L. B Q repeat	Class	In B Q	▬ ▬ ▬ ▬ – –	Class
"	Number	"	"	No.
"	No. of words	"	"	W.
"	Date	"	"	Date.
"	Time	"	"	Time.
"	Station To	"	"	Stn. To.
"	Station From	"	"	Stn. F.
"	Name To	"	"	To.
"	Name From	"	"	F.
"	Address To	"	"	Address
"	word after Emergency	"	"	wa Emergency.
	word after ink-bottle, tooth-pick, cork-screw	"	"	wa J. B. C., C. Q. (these letters represent the numbers of words).
	All after tipster	"		After tipster,
	From allegory to botany			allegory to bo-

Figures.

Instead of repeating back figures, as is the rule at present, they are to be sent *over again* after the end of the message.

THE TELEGRAPHIC CONFERENCE AT ST. PETERSBURG.

THE Paris correspondent of the *Times*, writing on the 16th inst., gives an outline of the principal discussions at the recent International Telegraphic Conference.

One of the first questions raised was that of Sunday labour. Mr. H. C. Fischer, of the English Post Office Telegraphs, claimed the right of a limited day service on Sundays for those offices which have a complete day service. This, he said, was necessary on account of the suspension of nearly all labour on Sundays.

On the proposal of M. Vincent (Belgium), who objected to exceptions in favour of particular States, it was agreed that any country may limit the hours of Sunday service, notifying this measure to the International Bureau, which will apprise the other States.

The question of responsibility for the correct transmission and delivery of messages was brought up by the French delegates, who proposed that, as to messages on which an extra sum is paid for insurance, there should be some fixed limit of responsibility. To this it was objected that words difficult to transmit or copy might be used on purpose to set up a claim to compensation, and the Committee to which the proposal was referred reported by five to three against it.

M. Ailhaud (France) urged on its behalf that registered letters had never produced lawsuits or inconvenience, but he was willing to exclude cypher messages and to limit compensation to cases where the telegram had manifestly not fulfilled its object. As to the fact that in France scarcely two messages in 10,000 are *collationné*, either the number of collated despatches would not increase, and the responsibility proposed would be very slight, or it would augment, thus showing, that a public want had been satisfied. American private companies, he mentioned, since 1861 have adopted this plan, the *maximum* compensation being 100 times the cost of the message.

Herr Stephan (Germany) took the same view, thinking it unfair that the Government, when guilty of miscarriage, should be shielded from responsibility. The principle of compensation would operate as a fine on the operator and induce greater care. Inquiry, moreover, would always show whether the sender had been guilty of bad faith, or whether injury had been sustained.

On the other hand, Signor D'Amico (Italy) urged that the telegraph was more liable to error than the Post Office, that faulty operators were already punished, that the best operators, owing to the nervousness consequent on their employment, oftenest committed mistakes, and that the system should first be tried in France or some other country.

Herr Stephan, in reply, said nervous operators ought to be dismissed.

M. Faber (Denmark), contended that the compensation should be divided among all the States sharing in the payment made for the telegram, but it was explained that the extra payment would be shared among all the States concerned, while the compensation would fall on the one guilty of the irregularity.

M. Nielson (Norway) suggested that the indemnity should be limited to five times the cost of the message.

Eventually it was agreed that a special committee of seven members should consider the question. This committee, by five to three, agreed that the sender of a registered message should be entitled to the return of his money and a fixed sum of 50 francs, the latter, however, not applying to irregularities caused by *force majeure* or

unavoidable circumstances; that such messages should be collated throughout; that they should be written in the language of the country whence despatched or in French, cypher messages, or those addressed to several recipients, being excluded; that the charge should be treble the ordinary charge, divisible among the countries concerned in the transmission, and that compensation, if awarded by the office where the message originated, should be paid by the officers guilty of the irregularity. The Conference adopted these regulations by 13 to 6.

M. Faber mentioned that in Denmark compensation is allowed both for inland and foreign messages, but very few claims ever arose.

There were repeated discussions on the admission of urgent telegrams at special rates. This was proposed by Italy and Holland, Signor D'Amico stating that in Italy the charge was quintupled, and that 4 per cent of the messages were urgent; but Herr Brunner (Austria) urged that all international messages were urgent, and that the system would cause less attention to be paid to messages at ordinary rates.

M. Vincent stated that between Brussels and Vienna the average time of transmission was two hours, that priority was important in some cases, and that from 1855 to 1858 urgent messages were accepted by France, Belgium, Spain, Sardinia, and Switzerland. It was explained that Government messages would have precedence over urgent messages.

Mr. Alan Chambre (England) said he was instructed not to accept urgency, and Mr. Fischer said English messages were always forwarded in the order of arrival, special wires being used for Stock Exchange messages.

Colonel Hammer (Switzerland) objected to the proposal as inconsistent with the principle of equality.

M. Vincent, in supporting it, stated that in Belgium the extra charge was only 1 f., yet the proportion of urgent messages was only 1 per cent. A member had humorously suggested that a sender should be able to claim reduced rates for his telegrams being sent after others.

Herr Stephan suggested that any administration should have the option of refusing urgent messages wherever there were not several wires. On a division, nine voted for the proposal and eight against it, while the English and Swiss delegates were neutral pending fresh instructions. They subsequently stated that their Governments objected to the proposal. Herr Stephan contended that a platonic sentiment of equality should not preclude really important messages affecting matters of life and death from having priority over trivial ones.

Mr. Fischer stated that urgent messages passing through England would not have priority, but would be despatched in the order of arrival like ordinary ones.

M. Vincent thereupon proposed that the scheme should not be binding on England.

M. Despecher said the cable companies between England and the Continent had no objection to receiving urgent despatches *in transitu*, and believed that Parliament might decide the question in a different sense from the Government. M. Vincent's proposal was adopted by 15 to 2. Another question discussed was the rate for press messages. The English, French, German, Belgian, Dutch, and Swiss delegates proposed that two or more administrations might agree on a special tariff for Press messages at night, or on letting a wire during certain hours.

M. Vincent said this was necessary for giving the international service a power largely used by England and America in their inland service, and one recently applied in the relations between Paris and London.

Mr. Chambre, being asked for information on this point, stated that by virtue of an arrangement concluded between England and France, the Press was allowed the use of special wires between Paris and London. At present the *Times* alone took advantage of this privilege, hiring from 9 p.m. to 3 a.m. a wire by which communications destined for publication were transmitted to it exclusively.

Herr Stephan remarked on the financial advantages of utilising the wires during the night, when they would otherwise be unproductive. It might be stipulated that Press messages should yield precedence to others. After some conversation as to whether any resolution was necessary to legalise such contracts with the Press, the subject was adjourned till a subsequent sitting, when the Committee proposed that wires might be let to the Press at night at a reduced rate without prejudice to the general service. Herr Stephan alluded to the favourable results of the system as regarded Paris and London, remarking that it was necessary to confine it to the Press, otherwise persons might abuse it by hiring a wire and sending messages delivered to them by the public. Only the Austrian delegates on the Committee had voted against this restriction.

Herr Brunner suggested that the Press would not send more matter, but would simply pay less for it, and that there was a possibility of its becoming an agency for private messages..

M. Vincent replied that these fears were ill-founded. The *Times* not only had day messages, but now received by wire letters formerly forwarded by post. Private persons were not likely to send messages to the Press to be forwarded at night, and such an abuse would be guarded against in the agreement.

M. Ducote (France) explained the mode of transmission of the *Times* messages, and testified to the loyalty with which the *Times* observed the agreement.

Mr. Chambre remarked that the night messages, far from lessening the day messages of the *Times*, had increased them. The proposal of the Committee was then carried by 15 to 4, on the understanding suggested by the Italian delegate that private messages should never be delayed in consequence.

London was chosen as the place of the Congress of 1878 by 14 votes, against two given for Berne, one for Berlin, and one for Constantinople.

Mr. Chambre stated at a subseqnent sitting that the British Government willingly agreed to this selection, and he assured the delegates that they would be welcome guests. The 1st of January, 1876, was fixed as the date of the operation of the new Convention.

NOTES.

We have already informed our readers of the satisfactory settlement of the dispute between the Chinese Government and the Great Northern Telegraph Company (Electrical News, vol. i., p. 41). We have now to record the establishment of an Imperial College of Torpedo Engineering, of which Mr. J. A. Betts, M.S.T.E. (who acted as arbitrator for the Chinese Government in the settlement of the above-mentioned dispute) is the Engineer-in-Chief. Already there are about forty students, and the course of instruction includes the manufacture of torpedoes, mooring and placing them in position, the use of the "firing arcs" in torpedoes fired by observation, lime light signalling, &c. There is also a class for instruction in practical telegraphy, testing, &c. At the Arsenal inside the city the mechanical parts necessary for the completion of a stock of torpedoes are being manufactured.

The practice of hanging linen to dry on the telegraph wires has, according to the *Pall Mall Gazette*, lately

become general in that country, and revealed the hitherto unknown fact that the Armenian peasantry are in the habit occasionally of washing their clothes. Much dismay has, however, been caused by an order that has been issued by the authorities forbidding the continuance of this arrangement. It seems that the wires have on more occasions than one been broken by awkward washerwomen, and Shefket Effendi, who has just been appointed director of the telegraph at Erzeroum, has solemnly declared that no more shirts, stockings, or other garments, shall be hung on the wires on any pretence whatever.

It is, says the *Examiner*, suspected that the Government mean to act upon the Report of the Committee on Telegraphs, and raise the rates for postal telegrams at once. This should be emphatically protested against; they ought at least to wait till Mr. Scudamore's reply to the Committee has been published, and the subject has been fully discussed, and public opinion clearly expressed. In reply to Mr. Reed, Lord John Manners said he trusted that Mr. Scudamore would favour him with his observations upon the Report, but he was unable to say at present whether the paper could be laid on the table of the House of Commons. That Mr. Scudamore's views on the subject differ very widely from those of the Committee there can be little doubt, and the expediency of his answer being published before either of the recommendations of the Committee are adopted, cannot be called in question.

ELECTRICAL SCIENCE IN FOREIGN JOURNALS.

(This column is devoted to a list of Electrical Memoirs published in Foreign Journals. Those of importance will be either translated in full or given in abstract.)

Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences. Vol. lxxxi., No. 5, August 2, 1875.

Magnets composed of Compressed Powders.—J. Jamin.—De Haldat published, during 1836, in the *Memoires l'Academie* of Stanislas, that he had put iron filings into a brass tube (closed by two screw plates), which he magnetised by the ordinary process, and that he succeeded in obtaining two contrary poles. The polarity slowly decreased when varying quantities of river sand were mixed with the filings, whilst in every case it was very weak, and disappeared when the metal grains were displaced in position by shaking the tube. I repeated this experiment by firmly ramming down the iron filings into the tube, by means of a small hydraulic press. I found that when the filings begin to aggregate the polarity considerably augments, and continues to increase with pressure. I now lay before your Academy some tubes, 3 to 10 c.m. long and 3 c.m. in diameter, which attract at least as powerfully as those made from broken pieces of good steel of the same dimensions. As the iron filings which I used were of unknown origin, I had some prepared under my own eyes, from good soft iron, perfectly reduced, and without appreciable coercive force: the results were not lessened. Thus, then, a metal which has no coercive force when it is entire acquires it in as considerable a degree as that of steel when it has been reduced and compressed by pressure. Is it not to this fragmentary character that we must attribute the observed polarity? and is it not, also, this same cause which explains the coercive force of steel? One cannot explain the distribution in a magnet without considering it as composed of rows of very small magnetic elements, of opposite poles, reacting between themselves at a distance; and it is proved that the quantities of separate magnetism in each of them increase, by this reaction, from the extremity to the middle line. Until now it seemed admissible that these elements are the molecules themselves; but the preceding experiment appears to show they are formed of either compacted iron fragments or small agglomerated crystals as in steel. When, before pressing the filings, materials which render the mass more homogeneous are put with them, the same polarity can no longer be given to them as before the mixture. For example, if we make a paste of chloride of iron and filings, and press it, we obtain, after several days, a subchloride of iron of continued appearance, which may be filed and polished like pure iron, but which can scarcely be magnetised. Iron reduced by hydrogen and oxygen from scales behave like iron filings; but magnetic or diamagnetic bodies mixed with the filings notably change its faculty of becoming magnetised. It is probable that, in very powerfully ramming home the powders, the coercive force would be found to increase to a maximum, and that it will afterwards decrease when the compactness of the fragments will have given a sufficient continuity to the mass. The prosecution of these questions promises great interest; but I regret I have not had at my disposal sufficient apparatus, nor a sufficiently powerful press in my laboratory, to enable me to continue them, though I believe facilities will shortly be placed at my disposal.

Journal de Physique, July, 1875.

Employment of Sheets of Collodion in Physics.—M. Gripon.—The author points out, *inter alia*, that few bodies are more easily electrified than collodion. With the least friction by the hand the membrane adheres to the fingers. If a collodion sheet be fixed, like a flag, to a glass tube, and waved in dry and hot air, it is electrified. Other uses of collodion sheets, here mentioned, are in experiments on polarisation of light, on colours of thin films, on diathermancy, on vibrations in acoustics. M. Gripon prepares these sheets by dissolving 1·5 to 1·7 grms. gun-cotton in a mixture of 50 grms. alcohol and 50 grms. ether. The collodion is poured on a glass plate after the latter has been breathed upon so as to receive a coating of moisture. When—after some hours—the collodion is dry, the plate is put in water, and a sheet of paper having been applied and attached to the collodion by the edges, the film is drawn off with the paper.

Note on the Action of Magnetism on the Induction-Spark.—M. Henri Becquerel.—When the electric current magnetising a strong electro-magnet is interrupted between the poles of the latter, the spark of the extra current produced is accompanied with a true detonation, and takes the form of a small flame projected by the magnetic action. M. Becquerel thinks the action of magnetism is here simply a mechanical one. The same phenomena are produced, if the electric circuit be broken, when a strong blast of air is made to play on it: the stronger the blast, the more intense is the sound. The effect in both cases would seem to be due to sudden rupture of the chain of molecules which transmits the electric current, of very short duration, constituting the induction discharge. The duration of the discharge being thus considerably diminished, the sound acquires remarkable intensity.

On Graphical Methods of Solving Certain Simple Electrical Problems.—Prof. G. Carey Foster.—(From *Philosophical Magazine.*)

Note of Vienna Academy's Proceedings, including Stefan on the Theory of Magnetic Forces; Boltzmann on Measurement of Dielectric Constants of Gases; Stefan on the Laws of Magnetic and Electric Forces in Magnetic and Electric Media, and

their Connection with the Theory of Light.—In the last it is stated that if the forces produce a positive work the total energy of the medium diminishes, and conversely. The electro-magnetic action of a current element on a magnetic pole does not undergo change through a magnetic medium. The action at a distance of a pole on the current element is diminished by the presence of the medium. There is no energy developed in the medium by co-existence of a current element and a magnetic pole. As to action of two current elements in a magnetic field, the calculation of the energy due to either leads to a formula which is the arithmetical mean of the expressions of electro-dynamic potential given by Neumann and Weber. The variations of this energy do not correspond to an equivalent work of electro-dynamic forces. Each positive work of these forces is accompanied with an increase of energy, whence we deduce the necessity of induction. The law of the induction can be determined. Applying this law to electric displacements of a dielectric medium, the equations fitting the latter agree with those given by the theory of light, not only in form, but in numerical values. The formula found for the energy excludes the propagation of a longitudinal displacement in the medium.

Les Mondes. Vol. xxxvii., No. 14. August 5, 1875.

On a Transformation of the Electric Spark from Holtz's Machine.—M. Demoyet.—It is well known that the sparks obtained from a Holtz machine are compounded of several continuous streams of luminous filets, of a brilliant white colour. In reality the luminous jets succeed each other, as may be verified by rapidly changing one of the poles, and it is merely the persistence of the retina's image which gives the appearance of several simultaneous jets. Now, let one of the poles of a Holtz machine, or of a coil, be put in connection with a Ruhmkorff insulated metallic circle, in whose interior turns a bent wire terminated by a point or a ball, and joined to the other pole. This wire in turning changes its position parallelly to the metallic circle, the sparks are given out successively, and, if the movement be regular, at equal distances: the effects may be varied by enlarging or contracting the circle, or lengthening and shortening the movable stem. If a resistance be interposed between the two points, by means of an isolating plate pierced with a small hole, the sparks become intermittent, and are accompanied by a reddish nimbus. If a resistance coil of fine wire, two- or three-tenths of a millimetre thick and 50 to 100 metres long, wound on an insulated core, be placed in the circuit (and plunged into petroleum to increase the helix's insulation), intermitting sparks are obtained with a reddish nimbus, in all respects similar to those from the Ruhmkorff coil, and having the same properties. If, instead of winding the wire of the resistance coil upon itself, it be stretched in a straight line, to avoid extra currents, analogous—but less intense—effects to the foregoing are obtained. From this we may conclude that this transformation of the spark is due—(1) to the resistance of the wire; (2) to the induction of the current upon itself. When a soft iron core is used for the coil the results are decreased, on account of magnetisation; and this explains why the results obtained from the fine wire of a Ruhmkorff coil are less than those from a fine wire simply twined around an insulated core. A portion of the electromotive force is employed in producing—(1) a current in the thick wire; (2) magnetisation in the soft iron core.

Poggendorff's Annalen der Physik und der Chimie, No. 7, 1875.

Spectral Analytic Researches.—R. Bunsen (continued from previous number).—Width of slit is the most important influence on the aspect of a continuous spectrum —next in importance is intensity of light. The heat of the jar-spark gives many lines which are not given (or only weakly) by the simple spark or the non-luminous gas-flame. Kirchhoff showed that the relative intensity of individual lines is not altered in a regular way by a rise of temperature; hence the relatively weakest lines in the flame-spectrum are sometimes the strongest in the spark-spectrum. On the other hand, it may surprise one to find that for many substances the flame-spectrum greatly exceeds the spark-spectrum in distinctness and number of lines: the explanation is, that the less-heated flame-column—on account of its greater size—sends light of considerably greater intensity to the slit than the small gas column, of comparatively higher temperature, of the spark-path. Hence those substances whose spectra already appear at low temperatures are best observed in the gas-flame, not in the spark; such are the alkalies, alkaline earths, indium, thallium, and some others. The spark temperature should be variable within not very wide limits, and the width of slit kept constant. With the usual *single* prism, it is best to narrow the slit, so that the two chloride of yttrium bands in the red are already dissolved in the clearly distinguishable system of lines; and the induction-current should be of such strength that the striking distance of the spark between two round pointed wires is about 2 c.m. The author gives the results of his study of various spectra.

Experimental Determination of the Dielectricity Constants of some Gases.—M. L. Boltzmann.—The dielectric constant of vacuum is taken as unity. The square root of the constant of a gas is, according to Maxwell's theory, equal to the index of refraction of the gas. The following table gives M. Boltzmann's figures obtained from experiment, with a pressure of 760 m.m.:—

	$\sqrt{D}$.	*i*.
Air	1·000295	1·000294
Carbonic acid	1·000473	1·000449
Hydrogen	1·000132	1·000138
Oxide of carbon ..	1·000345	1·000340
Protoxide of nitrogen	1·000497	1·000503
Olefiant gas	1·000656	1·000678
Marsh gas	1·000472	1·000443

The dielectric constant of sulphur changes, conformably to Maxwell's theory, when taken in a different direction relatively to the optic axes of the crystal.

An Experiment on the Electro-Dynamic Action of the Polarising Current.—MM. Schiller and Colley.—The authors' object was to find whether a liquid conductor exerts electro-dynamic action while the electrodes in it are polarised. In a Wiedemann galvanometer, which has two movable wire-coils on the two sides of the magnet, one coil was removed, and a spirally wound caoutchouc tube substituted. In this were put distilled acidulated water and two platinum electrodes. A current of four Daniells, which, notwithstanding the great resistance, wrought considerable decomposition of the water, was sent in opposite directions through the liquid and the metallic spirals, and these were moved till they compensated each other in action on the magnet. Then one Daniell was substituted for the four Daniells. Neither at closing the circuit nor afterwards, on closing the wire, with the battery excluded, was the least movement observed in the magnet. Hence it follows that the process going on in the liquid is, in its action on the magnet, perfectly equivalent, both qualitatively and quantitatively, to the galvanic current passing in the metallic part of the circuit.

A Peculiar Case of Magnetisation.—M. J[illegible] (From *Comptes Rendus.*)

Magnetic Properties of Electrolytically-produced Iron.—M. W. Beetz.—The author notices some points of discrepance between M. Holz's results and his own. Some are accounted for by the fact that M. Beetz [illegible] with electrolytically-produced magnets, but M. Holz [illegible] electrolytically-produced iron, which he afterwards magnetised (an essential difference). The author is glad to find M. Holz confirms his observation (as against J[illegible]) that the iron produced from Klein's solution (green [illegible]

›som salt) has a high coercive force; also that s a considerable degree of such force in *all* galron.

3ro-Electric Tube, or Fulgurator, an Apparatus serving the Spectra of Metallic Solutions.— 'elachanal and Mermet.—(From *Annales de Chimie Physique.*) In this instrument (described several s ago) there is a vertical capillary tube, with a plawire movable in it, and permitting a solution to t drop-wise. This tube, supplied with the liquid reservoir, is fitted into the stopper of a tube which d below, and has a second platinum wire passing i its bottom. The distance apart of the two elechaving been adjusted, a spark is made to pass. ctric current acts mechanically, and facilitates the ' of the liquid; and if the apparatus is now placed e the slit of the spectroscope, the illuminated passing with suitable rapidity, allow of the spectral eing continuously observed. A second vessel is ed by a pipe with the side of the fulgurator tube, eives the excess of the escaping liquid.

Zeitschrift für Biologie, Band xi., Heft 2.

e Arrangements for Electrical Excitation: the i of Change of Tone of the Nerves of the iic Frog-Preparation.—M. Valentin.

:hiv. für Pathol. Anat. und Phys., Band lxiii., Heft 3 and 4.

ro-Therapeutic Observations.—M. C. Schwalbe.

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illetin de l'Academie Imperiale des Sciences de St. Petersburg.

he Velocity of Propagation of Excitation of inal Cord.—M. Cyon.

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ives für die Gesammte Phys., Band x., Heft 12.

rvations on the Velocity of Propagation of tion in Muscles.—M. Hermann.

Archives Neerlandaises, Tome ix., No. 1.

ıe Theory of Cosmic Origin of Polar Aurora. ın Baumhauer.

COMMERCIAL NOTES.

dia-Rubber, Gutta-Percha, and Telegraph Works ıy have heard from Mr. Gray, who is in charge of xpedition, that the second section of their West f South America Cables has been successfully comthat, namely, from Islay to Arica, both in Peru. ction is about 200 miles long, and increases the total completely laid to 660 miles. The report of the ditates that during the half-year ended the 30th of June cable sales amounted to £72,573, against £63,933 ame period of 1874 and £34,285 in the same period . The general sales for the half-year amounted to ;, against £87,906 in the same period of 1874, and £80,784 in the same period of 1873. The business ın for the half-year also shows an improvement e corresponding period of 1874. The valuation of 'ertown property exceeded by £17,000 the amount books. With regard to the patents and goodwill , which had been brought down to £45,115 from an £130,000, the directors consider that the comexisting patents and the goodwill of its general s warrant them in keeping the account open, but ıprove the recommendation of the committee apto inquire into the concerns of the company, that ı should be gradually reduced. The Board express their indebtedness to this committee for their suggestions, which will be carefully considered in the interests of the company. With regard to the cables now being laid in Peru and Chili, each length of cable as it is completed, and also each section after it is shipped and covered with water, are tested by Messrs. Clark, Forde, and Co. The cable which was made for the West India and Panama Telegraph Company, after the settlement of the suit with them, was tested and accepted by their engineer, Sir Samuel Canning. The cables made for the Direct Spanish Telegraph Company continued to work well, and were earning an increasing income for that company.

The traffic receipts of the Submarine Telegraph Company for the month of July, 1875, amounted to £10,315 12s. 4d., and for the corresponding month of the preceding year to £9,274 12s. 9d.

The traffic receipts of the Anglo-American Telegraph Company for the 11th inst. were £1330; for the 12th inst., £1300; for the 13th, £1330; for the 14th, £1300; for the 15th, £300; for the 16th, £1130; for the 17th, £1340.

TELEGRAPH SHARE LIST.

Amount per Share.	NAME OF COMPANY.	Amount paid up.	Closing Quotations.
£		£	Aug. 18.
Stock	Anglo-American	100	59½—60½
10	Black Sea	All	2—4
10	Brazilian Submarine	All	6¼—6¾
10	Cuba	All	8¼—8¾
10	Ditto, 10 per cent Preference ..	All	14—15
10	Direct Spanish	9	6—6¼
10	Ditto, 10 per cent Preference ..	All	12—13
20	Direct United States Cable	All	8¾—9¼
10	Eastern	All	6⅞—7⅛
..	Ditto, 6 per cent Debenture	..	102—105
10	Ditto, Exten. Australia and China	All	7¼—7¾
10	German Union Telegraph and Trust	All	7¾—8¼
10	Globe Telegraph and Trust	All	5¾—6
10	Ditto, 6 per cent Preference	All	10—10½
10	Great Northern	All	9½—10
25	Indo-European	All	19—21
10	Mediterranean Extension	All	2¾—3¼
10	Ditto, 8 per cent Preference	All	10—10½
10	Panama and South Pacific	2½	2⅛—2⅜
8	Reuter's	All	9¾—10¼
Stock	Submarine	100	190—200
1	Ditto, Scrip	All	1⅞—2
10	West India and Panama	All	2¼—2¾
10	Ditto, 10 per cent Preference ..	All	10¼—10¾
20	Western and Brazilian	All	12¾—13¼
1000 dls.	Western Un. U.S. 7 per cent 1st M.B.	All	106—108
100	Ditto, 6 per cent	All	91—92
10	Hooper's Telegraph Works	All	7¾—8¼
50	India-Rubber and Gutta-Percha ..	All	19—20
Cert.	Submarine Cables Trust	100	96—99
12	Telegraph Construction	All	23—23½
100	Ditto, 7 per cent Bonds	All	100—103

At the eighth ordinary general meeting of the shareholders of the Cuba Submarine Telegraph Company, Limited, held on the 17th inst. at the London Tavern, the report, to which we referred in our last issue, was adopted. It was stated that the new cable, contracted for with Hooper's Telegraph Works Company, Limited, was successfully laid, in April last, from Cienfuegos to Santiago de Cuba, and had continued to work satisfactorily. At the same time the old cable was cut, and the ends landed at Cienfuegos, thereby establishing duplicate means of communication between Havannah and Santiago, as contemplated by the directors' special report of June 2, 1874. In the course of the half-year interruptions had occurred on the lines of contiguous companies, but, being of short duration, had not materially affected the revenue of the company. The chairman (Mr. T. Hughes), in moving the adoption of the report, said, as to the rumours which he heard had been circulated in reference to the old cable—that, although the work had been successfully done, yet that the old cable was in a very unsatisfactory state, and liable to break down at any time—all the directors could say was that the evidence and information they had did not bear out any idea of that kind. So far as they knew, the old cable was in excellent state, and there were speci-

mens of it on the table, which the shareholders could see for themselves. If they compared their former reports and accounts with the present, they would find that the earnings of the past half-year had exceeded those of any previous year except one. The retiring director, Mr. Hughes, and the retiring auditor, Mr. Cowen, having been re-elected, the proceedings terminated.

PATENTS.

APPLICATIONS FOR LETTERS PATENT.

2787. John Henry Johnson, gentleman, of 47, Lincoln's Inn Fields, Middlesex, for an invention of "Improvements in producing electric signals, fires, and lights, and in the apparatus employed therein."—A communication to him from abroad by François Ernest de Mersanne, of Paris, France.—Dated August 7, 1875.

2803. Robert Morley, Secretary to the Improved Electric Telegraph Company, Limited, of 116, Palmerston Buildings, London, for an invention of "Improvements in electric telegraphs."—A communication to him from abroad by Julien Godener, of 57, Rue de l'Ouest, Paris, France.—Dated August 9, 1875.

2806. Nathaniel John Holmes, gentleman, of The Hall, Primrose Hill Road, Regent's Park, London, Middlesex, for an invention of "Improvements in the construction of audible alarm signals for marine and other purposes."—Dated August 10, 1875.

2844. Sir James Anderson, Knight, of 66, Old Broad Street, London, Edward Bull, electrician, and George Oscar Spratt, both of Porthcurno, Cornwall, for an invention of "Improvements in electric telegraph apparatus."—Dated August 12, 1875.

GRANTS OF PROVISIONAL PROTECTION FOR SIX MONTHS.

2707. To William Marston Warden, John Muirhead, and Josiah Latimer Clark, all of 29, Regent Street, Westminster, for the invention of "Improvements in galvanic batteries."

INVENTIONS PROTECTED FOR SIX MONTHS

On the Deposit of Complete Specifications.

Notice is hereby given, that the petition of—

2740. William Clark, patent agent, of 53, Chancery Lane, Middlesex, praying for Letters Patent for the invention of "Improved electric railway signalling apparatus,"—a communication to him from abroad by David Rousseau, of New York, U.S.A.,—was deposited and recorded in the Office of the Commissioners on the 4th day of August, 1875, and a Complete Specification accompanying such petition was at the same time filed in the said office.

PATENTS WHICH HAVE BECOME VOID.

2327. Edward Augustine Calahan, telegraphic engineer, of Brooklyn, New York, U.S.A.. now of 8, Southampton Buildings, London, for an invention of "Improvements in telegraphic printing instruments, and in apparatus connected therewith."—Dated August 3, 1872.

PATENTS

On which the Stamp Duty of £100 has been paid, and Dates of their Production for Certificate.

6th August.

2505. Matthew Gray, engineer, of Highbury Hill, Middlesex, and Frederick Hawkins, electrician, of Silvertown, Essex, for an invention of "Improvements in the mode of and apparatus used in manufacturing telegraphic insulated wires and cables."—Dated August 11, 1868.

ABSTRACTS OF SPECIFICATIONS.

Improvements in the means and apparatus for indicating the speed of ships. Henry Edward Hargreaves, Rio de Janeiro, Brazil; at present of No. 12, Fenchurch Street, London. January 30, 1875.—No. 353. This invention relates to electric logs, wherein the revolutions of the vanes of the log cause an electric current to be passed at certain intervals along a conducting wire passing from the log to a recording instrument on board ship. According to the present improvements, the revolutions of the screw vanes effect the rotation of a worm and worm-wheel, on which is a stud that at every revolution of the wheel causes a contact-spring to close an electric circuit comprising a battery and a recording instrument on board ship. The recording instrument is an ordinary Morse receiving instrument, the paper strip being marked with divisions representing hours and minutes, so that the number of divisions occurring between two marks made on the paper by the passing of two consecutive currents will indicate the time in which the vessel traversed the distance corresponding to one revolution of the worm-wheel of the log.

Improvements in duplex and multiplex telegraphs. Thomas Alva Edison, of Newark, New Jersey, U.S.A. February 2, 1875.—No. 384. This invention relates to improvements in telegraph instruments and circuits, whereby one wire can be used simultaneously by two operators at both terminal stations, one to send and the other to receive, usually known as a duplex telegraph; also one wire can be simultaneously used by two operators to transmit and two operators to receive at each end, called a quadruplex telegraph. A circuit preserving key brings into operation the whole battery or only a portion to operate one set of electro-magnetic instruments by the rise and fall of tension. Another key reverses the current without breaking the circuit, and a polarised relay magnet responds to the reversal. Rheostats, condensers, and induction-coils are inserted to neutralise static discharges, to equalise and neutralise the action of the currents sent on the receiving instruments at that station, and leave them free to respond to the currents from the distant station; also to establish artificial lines of equal resistance to the main line, and thereby to balance the electrical forces. The polarised relay and differential electro-magnet operate by local circuits the instruments that receive the messages, and indicate the same by sound or marks. At intermediate stations the instruments are arranged so as to work to either terminal station, or by connecting them a relay is effected, so that on long lines the operator at a terminal station works a relay at an intermediate station to send to the distant terminal station, and this is used either in the duplex or quadruplex telegraphs.

Improvements in the production of electric light, and in apparatus therefor. Stephan Alexandrovitch Kosloff, of St. Petersburg, Russia, but at present of London. February 5, 1875.—No. 441. Placing the carbons on insulators, introducing the metal wire into the carbon, and connecting it by hinges of metal; producing the nitrogen gas by rarefying the air in the globe by means of the lighted carbons, and letting the heated air escape; filling up the space in globe, and using an automatic mechanism for the passage of the electric current from one carbon to the other in case of breakage of one of the carbons.

TO CORRESPONDENTS.

*** Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which "The Electrical News and Telegraphic Reporter" is the organ, will always command attention. Literary communications and books for review should be addressed to the Editor; business communications to the Publisher, Boy Court, Ludgate Hill, London, E.C.

Erratum.—In Vol. i., page 60, line 12 from top, *for* 69,920 [illegible]

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LONDON: BOY COURT, LUDGATE HILL, E.C.

London: Printed and Published by the Proprietor, WILLIAM CROOKES, at the Office, Boy Court, Ludgate Hill, E.C.
August 19, 1875.

THE

ELECTRICAL NEWS

AND

Edited by Wm. Crookes, F.R.S., &c.

TELEGRAPHIC REPORTER.

[Registered for Transmission Abroad.

Vol. 1.—No. 9.] Thursday, August 26, 1875. [PRICE, 4d. POST FREE, 4½d.

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E ELECTRICAL NEWS.

VOL. I. No. 9.

BRITISH ASSOCIATION
FOR THE
VANCEMENT OF SCIENCE.

BRISTOL MEETING, AUGUST 25, 1875.

UGURAL ADDRESS OF THE PRESIDENT,
Sir JOHN HAWKSHAW, F.R.S.

LEMEN,—To those on whom the British Association rs the honour of presiding over its meetings, the e of a subject presents some difficulty.

: Presidents of Sections, at each annual meeting, in account of what is new in their respective depart- ; and essays on science in general, though desirable nteresting in the earlier years of the Association, d be less appropriate to-day.

st Presidents have already discoursed on many sub- on things organic and inorganic, on the mind and ings perhaps beyond the reach of mind; and I have :d at the conclusion that humbler themes will not be f place on this occasion.

propose in this Address to say something of a pro- on to which my lifetime has been devoted—a theme cannot perhaps be expected to stand as high in estimation as in my own, and I may have some ulty in making it interesting; but I have chosen it use it is a subject I ought to understand better than other. I propose to say something on its origin, its , and kindred topics.

.pid as has been the growth of knowledge and skill pplied to the art of the engineer during the last ıry, we must, if we would trace its origin, seek far among the earliest evidences of civilisation.

early times, when settled communities were few and ted, the opportunities for the interchange of know- e were scanty or wanting altogether. Often the ly accumulated results of the experience of the wisest ls and the most skilful hands of a community were on its downfall. Inventions of one period were lost found again. Many a patient investigator has puzzled orain in trying to solve a problem which had yielded more fortunate labourer in the same field some cen- :s before.

he ancient Egyptians had a knowledge of Metallurgy, h of which was lost during the years of decline which owed the golden age of their civilisation. The art of ing bronze over iron was known to the Assyrians, igh it has only lately been introduced into modern allurgy; and patents were granted in 1609 for pro- ies connected with the manufacture of glass, which been practised centuries before.* An inventor in the n of Tiberius devised a method of producing flexible is, but the manufactory of the artist was totally troyed, we are told, in order to prevent the manufacture copper, silver, and gold from becoming depreciated.†

again and again engineers, as well as others, have made takes from not knowing what those had done who have e before them, and have had the same difficulties to tend with. In the long discussion which took place o the practicability of making the Suez Canal, an early ection was brought against it that there was a difference 32½ feet between the level of the Red Sea and that of the Mediterranean. Laplace at once declared that such could not be the case, for the mean level of the sea was the same on all parts of the globe. Centuries before the time of Laplace the same objection had been raised against a project for joining the waters of these two seas. According to the old Greek and Roman historians, it was a fear of flooding Egypt with the waters of the Red Sea that made Darius, and in later times, again, Ptolemy, hesitate to open the canal between Suez and the Nile.* Yet this canal was made, and was in use some centuries before the time of Darius.

Strabo† tells us that the same objection—that the adjoining seas were of different levels—was made by his engineers to Demetrius,‡ who wished to cut a canal through the Isthmus of Corinth some two thousand years ago. But Strabo‖ dismisses at once this idea of a dif- ference of level, agreeing with Archimedes that the force of gravity spreads the sea equally over the earth.

When knowledge in its higher branches was confined to a few, those who possessed it were often called upon to perform many and various services for the communities to which they belonged; and we find mathematicians and astronomers, painters and sculptors, and priests, called upon to perform the duties which now pertain to the pro- fession of the architect and the engineer. And as soon as civilisation had advanced so far as to admit of the accumulation of wealth and power, then kings and rulers sought to add to their glory while living by the erection of magnificent dwelling-places, and to provide for their aggrandisement after death by the construction of costly tombs and temples. Accordingly, we soon find men of ability and learning devoting a great part of their time to building and architecture, and the post of architect be- came one of honour and profit. In one of the most ancient quarries of Egypt a royal high architect of the dynasty of the Psammetici has left his pedigree sculptured on the rock, extending back for twenty-three generations, all of whom held the same post in succession in connec- tion with considerable sacerdotal offices.§

As there were in these remote times officers whose duty it was to design and construct, so also there were those whose duty it was to maintain and repair the royal palaces and temples. In Assyria, 700 years before our era, as we know from a tablet found in the palace of Sennacherib by Mr. Smith, there was an officer whose title was the Master of Works. The tablet I allude to is inscribed with a petition to the king from an officer in charge of a palace, requesting that the Master of Works may be sent to attend to some repairs which were much needed at the time.¶

Under the Roman Empire there was almost as great a division of labour in connection with building and design as now exists. The great works of that period were executed and maintained by an army of officers and work- men, who had special duties assigned to each of them.

Passing by those early attempts at design and construc- tion which supplied the mere wants of the individual and the household, it is to the East that we must turn if we would find the earliest works which display a knowledge of engineering. Whether the knowledge of engineering, if we may so call it, possessed by the people of Chaldæa and Babylonia was of native growth or was borrowed from Egypt is, perhaps, a question which cannot yet be an- swered. Both people were agricultural, dwelling on fertile plains, intersected by great rivers, with a soil requiring water only to enable it to bring forth inexhaustible crops. Similar circumstances would create similar wants, and stimulate to action similar faculties to satisfy them. Apart from the question of priority of knowledge, we know that at a very early period—some four or five thousand years

Layard's "Nineveh and Babylon," p. 191; Beckman's "History nventions," vol. ii., p. 85.
Pliny, "Nat. Hist.," Bk. xxxvi., c. 66.

* Pliny, "Nat. Hist.," Bk. vi., c. 33.
† Strabo, c. iii., § 11.
‡ Demetrius I., King of Macedonia, died 283 B.C.
‖ Strabo, c. iii., Sec. 12.
§ "Discoveries in Egypt, Ethiopia, &c.," by Dr. Lepsius, 2nd edt., p. 318.
¶ Smith's (G.) 'Assyrian Discoveries," 2nd edit., p. 414.

ago at least—there were men in Mesopotamia and Egypt who possessed considerable mechanical knowledge, and no little skill in hydraulic engineering. Of the men themselves we know little: happily, works often remain when the names of those who conceived and executed them have long been forgotten.

It has been said that architecture had its origin not only in nature, but in religion; and if we regard the earliest works which required mechanical knowledge and skill, the same may be said of engineering. The largest stones were chosen for sacred buildings, that they might be more enduring as well as more imposing, thereby calling for improvement and invention of mechanical contrivances, to assist in transporting and elevating them to the position they were to occupy; for the same reason the hardest and most costly materials were chosen, calling for further improvement in the metal forming the tools required to work them. The working of metals was further perfected in making images of the gods, and in adorning with the more precious and ornamental sorts the interior and even external parts of their shrines.

The earliest buildings of stone to which we can assign a date, with any approach to accuracy, are the pyramids of Gizeh. To their builders they were sacred buildings, even more sacred than their temples or temple palaces. They were built to preserve the royal remains, until, after a lapse of 3000 years, which we have reason to believe was the period assigned, the spirit which had once animated the body should re-enter it.* Although built 5000 years ago, the masonry of the Pyramids could not be surpassed in these days; all those who have seen and examined them, as I myself have done, agree in this: moreover, the design is perfect for the purpose for which they were intended, above all to endure. The building of pyramids in Egypt continued for some ten centuries, and from sixty to seventy still remain, but none are so admirably constructed as those of Gizeh. Still, many contain enormous blocks of granite from 30 to 40 feet long, weighing more than 300 tons, and display the greatest ingenuity in the way in which the sepulchral chambers are constructed and concealed.†

The genius for dealing with large masses in building did not pass away with the pyramid builders in Egypt, but their descendants continued to gain in mechanical knowledge, judging from the enormous blocks which they handled with precision. When the command of human labour was unlimited, the mere transport of such blocks as the statue of Rameses the Great, for instance, which weighed over 800 tons, need not so greatly excite our wonder; and we know how such blocks were moved from place to place, for it is shown on the wall paintings of tombs of the period which still remain.

But as the weight of the mass to be moved is increased, it becomes no longer a question of only providing force in the shape of human bone and muscle. In moving, in the last century, the block which now forms the base for the statue of Peter the Great, at St. Petersburg, and which weighs 1200 tons, force could be applied as much as was wanted, but great difficulty was experienced in supporting it, and the iron balls on which it was proposed to roll the block along were crushed, and a harder metal had to be substituted.|| To facilitate the transport of material, the Egyptians made solid causeways of granite from the Nile to the Pyramids; and in the opinion of Herodotus, who saw them, the causeways were more wonderful works than the Pyramids themselves.§

The Egyptians have left no record of how they accomplished a far more difficult operation than the mere transport of weight—that is, how they erected obelisks weighing more than 400 tons. Some of these obelisks must have been lifted vertically to place them in position, as they were by Fontana in Rome in later times, when the knowledge of mechanics, we know, was far advanced.*

The practice of using large blocks of stone, either as monoliths or as forming parts of structures, has existed from the earliest times in all parts of the world.

The Peruvians used blocks weighing from 15 to 20 tons, and fitted them with the greatest nicety in their cleverly designed fortifications.†

In India, large blocks were used in bridges when the repugnance of Indian builders to the use of the arch rendered them necessary, or in temples where—as in the Temple of the Sun at Orissa—stones weighing from 20 to 30 tons form part of the pyramidal roof at a height of from 70 to 80 feet from the ground.‡ Even as late as the last century, Indians, without the aid of machinery, were using blocks of granite above 40 feet long for the door-posts of the gateway of Seringham, and roofing blocks of the same stone for a span of 21 feet.||

At Persepolis, in the striking remains of the palaces of Xerxes and Darius, more than one traveller has noted the great size of the stones, some of which are stated to be 55 feet long and 6 to 10 feet broad.

So in the Greek temples of Sicily, many of the blocks in the upper parts of the temples are from 10 to 20 tons weight.

The Romans, though they did not commonly use such large stones in their own constructions, carried off the largest obelisks from Egypt and erected them at Rome, where more are now to be found than remain in Egypt. In the temples of Baalbek, erected under Roman rule, perhaps the largest stones are to be found which have been used for building since the time of the Pharaohs. The terrace wall of one of the temples is composed of three courses of stones, none of which are less than 30 feet long; and one stone still lies in the quarry squared and ready for transport, which is 70 feet long and 14 feet square, and weighs upwards of 1135 tons, or nearly as much as one of the tubes of the Britannia Bridge.

I have not mentioned dolmens and menhirs, rude unhewn stones often weighing from 30 to 40 tons, which are found from Ireland to India, and from Scandinavia to the Atlas, in Africa. To transport and erect such rude masses required little mechanical knowledge or skill, and the operation has excited more wonder than it deserves. Moreover, Fergusson has gone far to show that the date assigned to many of them hitherto has been far too remote; most, and possibly all, of those in northern and western Europe having been erected since the time of the Roman occupation. And to this day the same author shows that menhirs, single stones often weighing over 20 tons, are erected by hill tribes of India in close proximity to stone buildings of elaborate design and finished execution, erected by another race of men.§

For whatever purpose these vast stones were selected—whether to enhance the value or to prolong the endurance of the buildings of which they formed a part—the tax on the ingenuity of those who moved and placed them must have tended to advance the knowledge of mechanical appliances.

The ancient Assyrians and Egyptians had possibly more knowledge of mechanical appliances than they are generally credited with. In the wall paintings and sculptures which show their mode of transporting large blocks of stone, the lever is the only mechanical power represented, and which they appear to have used in such operations; nor ought we to expect to find any other used, for, where the supply of human labour was unlimited, the most expeditious mode of dragging a heavy weight along would

* Fergusson's "History of Architecture," vol. i., p. 83; Wilkinson's "Ancient Egyptians," 2nd series, vol. ii., p. 444.
† Vyse's "Pyramids of Gizeh," vol. iii., pp. 16, 41, 45, 57.
‡ Rondelet's "Traité de l'Art de Bâtir," vol. i., p. 73.
|| Herodotus, Bk. ii., c. 124.

* For obelisk erected at Arles, 1676, see Rondelet's "L'Art de Bâtir," vol. i., p. 48. Its weight was nearly 200 tons, and it was suspended vertically by eight ships' masts.
† Fergusson's "History of Architecture," vol. ii., p. 779; Squier, "Peru," p. 24.
‡ The Temple of the Sun was built 1237—1282 A.D.—Hunter's "Orissa," vol. i., pp. 288, 297.
|| Fergusson's "Rude Stone Monuments," p. 96.
§ Fergusson's "Rude Stone Monuments," pp. 461—465.

be by human power; to have applied pulleys and capstans, such as would now be employed in similar undertakings, would have been mere waste of time. In some countries, even now, where manual labour is more plentiful than mechanical appliances, large numbers of men are employed to transport heavy weights, and do the work in less time than it could be done with all our modern mechanical appliances. In other operations, such as raising obelisks, or the large stones used in their temple palaces, where human labour could not be applied to such advantage, it is quite possible that the Egyptians used mechanical aids. On one of the carved slabs which formed part of the wall panelling of the palace of Sardanapalus, which was built about 930 years before our era, a single pulley is clearly shown, by which a man is in the act of raising a bucket—probably drawing water from a well.*

It has sometimes been questioned whether the Egyptians had a knowledge of steel. It seems unreasonable to deny them this knowledge. Iron was known at the earliest times of which we have any record. It is often mentioned in the Bible, and in Homer; it is shown in the early paintings on the walls of the tombs at Thebes, where butchers are represented as sharpening their knives on pieces of metal coloured blue, which were most probably pieces of steel.† Iron has been found in quantity in the ruined palaces of Assyria; and in the inscriptions of that country fetters are spoken of as having been made of iron, which is also so mentioned in connection with other metals as to lead to the supposition that it was regarded as a base and common metal. Moreover, in the Great Pyramid a piece of iron was found in a place where it must have lain for 5000 years.‡ The tendency of iron to oxidise must render its preservation for any long period rare and exceptional. The quality of iron which is now made by the native races of Africa and India is that which is known as wrought iron: in ancient times, Dr. Percy says the iron which was made was always wrought iron. It is very nearly pure iron, and a very small addition of carbon would convert it into steel. Dr. Percy says the extraction of good malleable iron directly from the ore "requires a degree of skill very far inferior to that which is implied in the manufacture of bronze." ‖ And there is no great secret in making steel: the natives of India now make excellent steel in the most primitive way, which they have practised from time immemorial. When steel is to be made, the proportion of charcoal used with a given quantity of ore is somewhat larger, and the blast is applied more slowly than when wrought iron is the metal required.§ Thus, a vigorous native working the bellows of skin would make wrought iron where a lazy one would have made steel. The only apparatus required for the manufacture of the finest steel from iron ore is some clay for making a small furnace 4 feet high, and from 1 to 2 feet broad, some charcoal for fuel, and a skin with a bamboo tuyere for creating the blast.

The supply of iron in India as early as the fourth and fifth centuries seems to have been unlimited. The iron pillar of Delhi is a remarkable work for such an early period. It is a single piece of wrought iron 50 ft. in length, and it weighs not less than 17 tons.¶ How the Indians forged this large mass of iron and other heavy pieces which their distrust of the arch led them to use in the construction of roofs, we do not know. In the temples of Orissa iron was used in large masses as beams or girders in roof-work in the thirteenth century.**

The influence of the discovery of iron on the progress of art and science cannot be over-estimated. India well repaid any advantage which she may have derived from the early civilised communities of the West if she were the first to supply them with iron and steel.

An interesting social problem is afforded by a comparison of the relative conditions of India and this country at the present time. India, from thirty to forty centuries ago, was skilled in the manufacture of iron and cotton goods, which manufactures, in less than a century, have done so much for this country. It is true that in India coal is not so abundant or so universally distributed as in this country. Yet, if we look still further to the East, China had probably knowledge of the use of metals as soon as India, and moreover had a boundless store of iron and coal. Baron Richthofen, who has visited and described some of the coalfields of China, believes that one province alone, that of Southern Shansi, could supply the world at its present rate of consumption for several thousand years. The coal is near the surface, and iron abounds with it. Marco Polo tells us that coal was universally used as fuel in the parts of China which he visited towards the end of the fourteenth century, and from other sources we have reason to believe it was used there as fuel 2000 years ago. But what progress has China made in the last ten centuries? A great future is undoubtedly in store for that country; but can the race who now dwell there develop its resources, or must they await the aid of an Aryan race? Or is anything more necessary than a change of institutions, which might come unexpectedly, as in Japan?

The art of extracting metals from the ore was practised at a very early date in this country. The existence long ago of tin mines in Cornwall, which are so often spoken of by classical writers, is well known to all. That iron was also extracted from the ore by the ancient Britons is most probable, as it was largely used for many purposes by them before the Roman conquest. The Romans worked iron extensively in the Weald of Kent, as we assume from the large heaps of slag containing Roman coins which still remain there. The Romans always availed themselves of the mineral wealth of the countries which they conquered, and their mining operations were often carried out on the largest scale, as in Spain, for instance, where as many as forty thousand miners were regularly employed in the mines at New Carthage.*

Coal, which was used for ordinary purposes in England as early as the ninth century, does not appear to have been largely used for iron smelting until the eighteenth century, though a patent was granted for smelting iron with coal in the year 1611.† The use of charcoal for that purpose was not given up until the beginning of this century, since which period an enormous increase in the mining and metallurgical industries has taken place; the quantity of coal raised in the United Kingdom in 1873 having amounted to 127 million tons, and the quantity of pig iron to upwards of 6½ million tons.

The early building energy of the world was chiefly spent on the erection of tombs, temples, and palaces.

While, in Egypt, as we have seen, the art of building in stone had 5000 years ago reached the greatest perfection, so in Mesopotamia the art of building with brick, the only available material in that country, was in an equally advanced state some ten centuries later. That buildings of such a material have lasted to this day shows how well the work was done; their ruinous condition even now is owing to their having served as quarries for the last three or four thousand years, so that the name of Nebuchadnezzar, apparently one of the greatest builders of ancient times, is as common on the bricks of many modern towns in Persia as it was in old times in Babylon. The labour required to construct the brick temples and palaces of Chaldæa and Assyria must have been enormous. The mound of Koyunjik alone contained 14½ million tons, and represents the labour of 10,000 men for twelve years. The palace of Sennacherib, which stood on this mound, was probably the largest ever built by any one monarch,

* Layard's "Nineveh and its Remains," vol. ii., p. 31.
† Wilkinson's "Ancient Egyptians," vol. iii., p. 247.
‡ Vyse's "Pyramids of Gizeh," vol. i., p. 275.
‖ Percy's "Iron and Steel," p. 873.
§ *Ibid.*, p. 259.
¶ Fergusson's "History of Architecture," vol. ii., p. 460; and "Rude Stone Monuments," pp. 481-3. Cunningham's "Archæological Survey of India," vol. i., p. 169.
** Hunter's "Orissa," vol. i., p. 298.

* Strabo, Bk. iii., c. ii., sec. 10.
† Percy's "Iron and Steel," p. 882.

containing as it did more than two miles of walls, panelled with sculptured alabaster slabs, and twenty-seven portals, formed by colossal bulls and sphinxes.*

The pyramidal temples of Chaldæa are not less remarkable for the labour bestowed on them, and far surpass the buildings of Assyria in the excellence of their brickwork.

The practice of building great pyramidal temples seems to have passed eastwards to India and Burmah, where it appears in buildings of a later date, in Buddhist topes and pagodas; marvels of skill in masonry, and far surpassing the old brick moulds of Chaldæa in richness of design and in workmanship. Even so late as this century a king of Burmah began to build a brick temple of the old type, the largest building, according to Fergusson, which has been attempted since the Pyramids.†

The mere magnitude of many of these works is not so wonderful when we take into account the abundance of labour which those rulers could command. Countries were depopulated, and their inhabitants carried off and made to labour for the conquerors. The inscriptions of Assyria describe minutely the spoils of war and the number of captives; and in Egypt we have frequent mention made of works being executed by the labour of captive peoples. Herodotus tells us that as many as 360,000 men were employed in building one palace for Sennacherib.‡ At the same time, it must not be forgotten that the very character of the multitude would demand from some one the skill and brain to organise and direct, to design and plan the work.

It would be surprising if men who were capable of undertaking and successfully completing unproductive works of such magnitude did not also employ their powers on works of a more useful class. Traces still remain of such works; enough to show, when compared with the scanty records of the times which have come down to us, that the prosperity of such countries as Egypt and Mesopotamia was not wholly dependent on war and conquest, but that the reverse was more likely the case, and that the natural capabilities of those countries were greatly enlarged by the construction of useful works of such magnitude as to equal, if not in some cases surpass, those of modern times.

Egypt was probably far better irrigated in the days of the Pharaohs than it is now. To those unacquainted with the difficulties which must be met with and overcome before a successful system of irrigation can be carried out, even in countries in which the physical conditions are favourable, it may appear that nothing more is required than an adequate supply of unskilled labour. Far more than this was required: the Egyptians had some knowledge of surveying, for Eustathius says they recorded their marches on maps;|| but such knowledge was probably in those days very limited, and it required no ordinary grasp of mind to see the utility of such extensive works as were carried out in Egypt and Mesopotamia, and, having seen the utility, to successfully design and execute them. To cite one in Egypt—Lake Mœris, of which the remains have been explored by M. Linant, was a reservoir made by one of the Pharaohs, and supplied by the flood waters of the Nile. It was 150 square miles in extent, and was retained by a bank or dam 60 yards wide and 10 high, which can be traced for a distance of thirteen miles. This reservoir was capable of irrigating 1200 square miles of country.§ No work of this class has been undertaken on so vast a scale since, even in these days of great works.

The prosperity of Egypt was in so great a measure dependent on its great river, that we should expect that the Egyptians, a people so advanced in art and science, would at an early period have made themselves acquainted with its *regimé*. We know that they carefully registered the height of the annual rise of its waters; such registers still remain inscribed on the rocks on the banks of the Nile, with the name of the king in whose reign they were made.* The people of Mesopotamia were equally observant of the *regimé* of their great rivers, and took advantage in designing their canals of the different periods of the rising of the waters of the Tigris and Euphrates. A special officer was appointed in Babylon, whose duty it was to measure the rise of the river; and he is mentioned in an inscription found in the ruins of that city, as recording the height of the water in the temple of Bel.† The Assyrians, who had a far more difficult country to deal with, owing to its rocky and uneven surface, showed even greater skill than the Babylonians in forming their canals, tunnelling through rock, and building dams of masonry across the Euphrates. While the greater number of these canals in Egypt and Mesopotamia were made for the purpose of irrigation, others seem to have been made to serve at the same time for navigation. Such was the canal which effected a junction between the Mediterranean and the Red Sea, which was a remarkable work, having regard to the requirements of the age in which it was made. Its length was about 80 miles; its width admitted of two triremes passing one another.‡ At least one of the navigable canals of Babylonia, attributed to Nebuchadnezzar, can compare in extent with any work of later times. I believe Sir H. Rawlinson has traced the canal to which I allude throughout the greater part of its course, from Hit on the Euphrates to the Persian Gulf, a distance of between four and five hundred miles.|| It is a proof of the estimation in which such works were held in Babylonia and Assyria, that, among the titles of the god Vul were those of "Lord of Canals," and "The Establisher of Irrigation Works."§

The springs of knowledge which had flowed so long in Babylonia and Assyria were dried up at an early period. With the fall of Babylon and destruction of Nineveh the settled population of the fertile plains around them disappeared, and that which was desert before man led the waters over it became desert again, affording a wide field for, and one well worthy of, the labours of engineers to come.

Such was not the case with Egypt. Long after the period of its greatest prosperity was reached, it remained the fountain head from whence knowledge flowed to Greece and Rome. The philosophers of Greece and those who, like Archimedes, were possessed of the best mechanical knowledge of the time, repaired to Egypt to study and obtain the foundation of their knowledge from thence.

Much as Greece and Rome were indebted to Egypt, it will probably be found, as the inscribed tablets met with in the mounds of Assyria and Chaldæa are deciphered, that the later civilisations owe, if not more, at least as much, to those countries as to Egypt. This is the opinion of Mr. Smith, who, in his work describing his recent interesting discoveries in the East, says that the classical nations "borrowed far more from the valley of the Euphrates than that of the Nile."¶

In the science of astronomy, which in these days is making such marvellous discoveries, Chaldæa was undoubtedly pre-eminent. Among the many relics of these ancient peoples which Mr. Smith has recently brought to this country is a portion of a metal astrolabe from the palace of Sennacherib, and a tablet on which is recorded the division of the heavens according to the four seasons, and the rule for regulating the intercalary month of the year. Not only did the Chaldeans map out the heavens

* Layard's "Nineveh and Babylon," p. 589.
† Fergusson's "History of Architecture," vol. ii., p. 523.
‡ Rawlinson's "Herodotus," vol. i., p. 389, second edition.
|| Rawlinson's "Herodotus," vol. ii., p. 278, second edition.
§ M. Linant's "Mémoire sur le lac Mœris.

* Lepsius's "Discoveries in Egypt," &c., p. 268.
† Smith's "Assyrian Discoveries," pp. 395-7, second edition.
‡ "Herodotus," Bk. ii., c. clviii.
|| Rawlinson's "Herodotus," vol. i., p. 420, second edition.
§ *Ibid.*, p. 498.
¶ Smith's (G.) "Assyrian Discoveries," p. 451, second edition.

and arrange the stars, but they traced the motion of the planets, and observed the appearance of comets; they fixed the signs of the zodiac, and they studied the sun and moon and the periods of eclipses.*

But to return to that branch of knowledge to which I wish more particularly to draw your attention, as it grew and spread from East to West, from Asia over Europe. Of all nations of Europe, the Greeks were most intimately connected with the civilisation of the East. A maritime people by the nature of the land they lived in, colonisation followed as a matter of course on the tracks of their trading vessels; and thus, more than any other people, they helped to spread Eastern knowledge along the shores of the Mediterranean, and throughout the South of Europe.

The early constructive works of Greece, till about the seventh century B.C., form a strong contrast to those of its more prosperous days. Commonly called Pelasgian, they are more remarkable as engineering works than admirable as those which followed them were for architectural beauty. Walls of huge unshapely stones—admirably fitted together, however—tunnels, and bridges, characterise this period. In Greece, during the few and glorious centuries which followed, the one aim in all construction was to please the eye, to gratify the sense of beauty; and in no age was that aim more thoroughly and satisfactorily attained.

In these days, when sanitary questions attract each year more attention, we may call to mind that twenty-three centuries ago the city of Agrigentum possessed a system of sewers, which, on account of their large size, were thought worthy of mention by Diodorus.† This is not, however, the first record of towns being drained; the well-known Cloaca Maxima, which formed part of the drainage system of Rome, was built some two centuries earlier, and great vaulted drains passed beneath the palace mounds of unburnt brick at Nimroud and Babylon; and possibly we owe the preservation of many of the interesting remains found in the brick mounds of Chaldæa to the very elaborate system of pipe drainage discovered in them, and described by Loftus.‡

Whilst Pelasgian art was being superseded in Greece, the city of Rome was founded in the eighth century before our era; and Etruscan art in Italy, like the Pelasgian art in Greece, was slowly merged in that of an Aryan race. The Etruscans, like the Pelasgians and the old Egyptians, were Turanians, and remarkable for their purely constructive or engineering works. Their city walls far surpass those of any other ancient race, and their drainage works and tunnels are most remarkable.

The only age which can compare with the present one in the rapid extension of utilitarian works over the face of the civilised world, is that during which the Romans, an Aryan race, as we are, were in power. As Fergusson has said, the mission of the Ayran races appears to be to pervade the world with useful and industrial arts. That the Romans adorned their bridges, their aqueducts, and their roads; that with a sound knowledge of construction they frequently made it subservient to decoration, was partly owing to the mixture of Etruscan or Turanian blood in their veins, and partly to their great wealth, which made them disregard cost in their construction, and to their love of display.

It would be impossible for me to do justice to even a small part of the engineering works which have survived fourteen centuries of strife, and remain to this day as monuments of the skill, the energy, and ability of the great Roman people. Fortunately, their works are more accessible than those of which I have spoken hitherto, and many of you are probably already familiar with them.

Conquerors of the greater part of the civilised world, the admirable organisation of the Romans enabled them to make good use of the unbounded resources which were at their disposal. Yet, while the capital was enriched, the development of the resources of the most distant provinces of the empire was never neglected.

War, with all its attendant evils, has often indirectly benefitted mankind. In the long sieges which took place during the old wars of Greece and Rome, the inventive power of man was taxed to the utmost to provide machines for attack and defence. The ablest mathematicians and philosophers were pressed into the service, and helped to turn the scale in favour of their employers. The world has to regret the loss of more than one, who, like Archimedes, fell slain by the soldiery while applying the best scientific knowledge of the day to devising means of defence during the siege.* In these days, too, science owes much to the labours of engineers and able men, whose time is spent in making and improving guns, the materials composing them, and armour plates to resist them, or in studying the motion of ships of war in a seaway.

The necessity for roads and bridges for military purposes has led to their being made where the necessary stimulus from other causes was wanting; and so means of communication, and the interchange of commodities, so essential to the prosperity of any community, have thus been provided. Such was the case under the Roman Empire. So, too, in later times, the ambition of Napoleon covered France and the countries subject to her with an admirable system of military roads. At the same time, we must do Napoleon the justice of saying that his genius and foresight gave a great impetus to the construction of all works favourable to commercial progress. So, again, in this country, it was the rebellion of 1745, and the want felt of roads for military purposes, which first led to the construction of a system of roads in it unequalled since the time of the Roman occupation. And lastly, in India, in Germany, and in Russia, more than one example could be pointed out where industry will benefit by railways which have originated in military precautions rather than in commercial requirements.

But to return to Rome. Roads followed the tracks of her legions into the most distant provinces of the empire. Three hundred and seventy-two great roads are enumerated, together more than 48,000 miles in length, according to the itinerary of Antoninus.

The water supply of Rome during the first century of our era would suffice for a population of seven millions, supplied at the rate at which the present population of London is supplied. This water was conveyed to Rome by nine aqueducts; and in later years the supply was increased by the construction of five more aqueducts. Three of the old aqueducts have sufficed to supply the wants of the city in modern times. These aqueducts of Rome are to be numbered among her grandest engineering works.† Time will not admit of my saying anything about her harbour works and bridges, her basilicas and baths, and numerous other works in Europe, in Asia, and in Africa. Not only were these works executed in a substantial and perfect manner, but they were maintained by an efficient staff of men divided into bodies, each having their special duties to perform. The highest officers of state superintended the construction of works, were proud to have their names associated with them, and constructed extensive works at their own expense.

Progress in Europe stopped with the fall of the Roman Empire. In the fourth and succeeding centuries the barbarian hordes of Western Asia, people who felt no want of roads and bridges, swept over Europe to plunder and destroy.

With the seventh century began the rise of the Mohammedan power, and a partial return to conditions apparently more favourable to the progress of industrial

* *Ibid.*

† Agrigentum was a celebrated Greek city, founded B.C. 582, population 200,000 (Diodorus, 406 B.C.), drained by Phœax, who lived B.C. 480.

‡ Rawlinson's "Five Ancient Monarchies," vol. i., pp. 89, 90, second edition.

* Archimedes, B.C. 287-212; killed at the siege of Syracuse by the Roman soldiers.

† Total length 250 miles; 50 on arches, 200 underground.

art, when widespread lands were again united under the sway of powerful rulers.* Science owes much to Arab scholars, who kept and handed on to us the knowledge acquired so slowly in ancient times, and much of which would have been lost but for them. Still, few useful works remain to mark the supremacy of the Mohammedan power at all comparable to those of the age which preceded its rise.

A great building age began in Europe in the tenth century, and lasted through the thirteenth. It was during this period that these great ecclesiastical buildings were erected, which are not more remarkable for artistic excellence than for boldness in design.

While the building of cathedrals progressed on all sides in Europe, works of a utilitarian character, which concern the engineer, did not receive such encouragement, excepting perhaps in Italy.

From the twelfth to the thirteenth centuries, with the revival of the arts and sciences in the Italian republics, many important works were undertaken for the improvement of the rivers and harbours of Italy. In 1481 canal locks were first used; and some of the earliest of which we have record were erected by Leonardo da Vinci, who would be remembered as a skilful engineer had he not left other greater and more attractive works to claim the homage of posterity.

The great use that has since been made of this simple means of transferring floating vessels from one water level to another, in connection not only with inland navigation, but in all the great ports and harbours of the world, renders it all the more deserving of remark.

In India, under the Moguls, irrigation works, for which they had a natural aptitude, were carried on during these centuries with vigour, and more than one emperor is noted for the numerous great works of this nature which he carried out. If the native records can be trusted, the number of hydraulic works undertaken by some rulers is surprising. Tradition relates that one king, who reigned in Orissa in the twelfth century, made one million tanks or reservoirs, besides building sixty temples, and erecting numerous other works.†

In India, the frequent overflow of the great rivers, and the periodical droughts, which rendered irrigation necessary, led to extensive protective works being undertaken at an early period; but as these works have been maintained by successive rulers, Mogul and Mohammedan, until recent times, and have not been left for our inspection, deserted and useless for 3000 years or more, as is often the case in Egypt and Mesopotamia, there is more difficulty in ascertaining the date of such works in India.

Works of irrigation were among the earliest attempts at engineering undertaken by the least civilised inhabitants in all parts of the world. Even in Australia, where savages are found as low as any in the scale of civilisation, traces of irrigation works have been found. These works, however, must be taken to show that the natives were once somewhat more civilised than we now find them. In Feejee, our new possession, the natives occasionally irrigate their land,‡ and have executed a work of a higher class, a canal some two miles long and sixty feet wide, to shorten the distance passed over by their canoes.‖ The natives of New Caledonia irrigate their fields with great skill.§ In Peru, the Incas excelled in irrigation as in other great and useful works, and constructed most admirable underground conduits of masonry for the purpose of increasing the fertility of the land.¶

It is frequently easier to lead water where it is wanted than to check its irruption into places where its presence is an evil, often a disaster. For centuries the existence of a large part of Holland has been dependent on the skill of man. How soon he began in that country to contest with the sea the possession of the land we do not know, but early in the twelfth century dykes were constructed to keep back the ocean. As the prosperity of the country increased with the great extension of its commerce, and land became more valuable and necessary for an increasing population, very extensive works were undertaken. Land was reclaimed from the sea, canals were cut, and machines were designed for lifting water. To the practical knowledge acquired by the Dutch, whose method of carrying out hydraulic works is original and of native growth, much of the knowledge of the present day in embanking, and draining, and canal making is due. The North Holland Canal* was the largest navigable canal in existence until the Suez Canal was completed; and the Dutch have just now nearly finished making a sea canal from Amsterdam to the North Sea, which, though not equal to the Suez Canal in length, will be as great in width and depth, and involves perhaps larger and more important works of art. This country was for many years beholden to the Dutch for help in carrying out hydraulic works. In the seventeenth century much fen land in the Eastern Counties was drained by Dutch labour, directed by Dutch engineers, among whom Sir Cornelius Vermuyden, an old campaigner of the Thirty Years' War, and a colonel of horse under Cromwell, is the most noted.

While the Dutch were acquiring practical knowledge in dealing with water, and we in Britain, among others, were benefiting by their experience, the disastrous results which ensued from the inundations caused by the Italian rivers of the Alps gave a new importance to the science of hydraulics. Some of the greatest philosophers of the seventeenth century—among them Torricelli, a pupil of Galileo†—were called upon to advise and to superintend engineering works. Nor did they confine themselves to the construction of preventive works, but thoroughly investigated the condition pertaining to fluids at rest or in motion, and gave to the world a valuable series of work on hydraulics and hydraulic engineering, which form the basis of our knowledge of these subjects at the present day.

Some of the best scientific works (prior to the nineteenth century) on engineering subjects we owe to Italian and French writers. The writings of Belidor, an officer of artillery in France in the seventeenth century, who did not, however, confine himself to military subjects, drew attention to engineering questions. Not long after their appearance the Ponts et Chausées‡ were established, which has maintained ever since a body of able men specially educated for, and devoted to, the prosecution of industrial works.

The impulse given to road-making in the early part of the last century soon extended to canals and means for facilitating locomotion and transport generally. Tramways were used in connection with mines at least as early as the middle of the seventeenth century, but the rails were, in those days, of wood. The first iron rails are said to have been laid in this country as early as 1738; after which time their use was gradually extended, until it became general in mining districts.

By the beginning of this century the great ports of England were connected by a system of canals; and new harbour works became necessary, and were provided, to accommodate the increase of commerce and trade, which improved means of internal transport had rendered possible. It was in the construction of these works that our own Brindley and Smeaton, Telford and Rennie, and other engineers of their time, did so much.

But it was not until the steam-engine, improved and almost created by the illustrious Watt, became such a

* "Under the last of the house of Ommiyah (750 A.D.) one command was obeyed almost along the whole diameter of the known world, from the banks of the Sihon to the utmost promontory of Portugal."—Hallam's "Middle Ages," vol. ii., p. 120, 2nd edition.

† King Bhim Deo, A.D. 1174, 60 temples, 10 bridges, 40 wells stone cased, 152 landing stairs, and one million tanks.—Hunter's "Orissa," vol. i., p. 100.

‡ Erskine's "Western Pacific," p. 171.

‖ Seeman, p. 82.

§ Erskine's "Western Pacific," p. 355.

¶ Markham's "Cieza" (note), p. 236.

* North Holland Canal, finished in 1825.

† Galileo, b. 1564; Torricelli, b. 1608.

‡ Ponts et Chaussées, established 1720.

potent instrument, that engineering works to the extent they have since been carried out became possible or necessary. It gave mankind no new faculty, but it at once set his other faculties on an eminence, from which the extent of his future operations became almost unlimited.

Water-mills, wind-mills, and horse-machines were in most cases superseded. Deep mines, before only accessible by adits and water levels, could at once be reached with ease and economy. Lakes and fens which, but for the steam-engine, would have been left untouched, were drained and cultivated.

The slow and laborious toil of hands and fingers, bone and sinew, was turned to other employments, where, aided by ingenious mechanical contrivances, the produce of one pair of hands was multiplied a thousand-fold, and their cunning extended until results marvellous, if you consider them, were atttained. Since the time of Watt the steam-engine has exerted a power, made conquests, and increased and multiplied the material interests of this globe to an extent which it is scarcely possible to realise.

But while Watt has gained a world-wide, well-earned fame, the names of those men who have provided the machines to utilise the energies of the steam-engine are too often forgotten. Of their inventions the majority of mankind know little. They worked silently at home, in the mill, or in the factory, observed by few. Indeed, in most cases these silent workers had no wish to expose their work to public gaze. Were it not so, the factory and the mill are not places where people go to take the air. How long in the silent night the inventors of these machines sat and pondered; how often they had to cast aside some long sought mechanical movement and seek another and a better arangement of parts, none but themselves could ever know. They were unseen workers, who succeeded by rare genius, long patience, and indomitable perseverance.

More ingenuity and creative mechanical genius is perhaps displayed in machines used for the manufacture of textile fabrics than by those used in any other industry. It was not until late in historical times that the manufacture of such fabrics became established on a large scale in Europe. Although in China man was clothed in silk long ago, and although Confucius, in a work written 2300 years ago, orders with the greatest minuteness the rules to be observed in the production and manufacture of silk, yet it was worth nearly its weight in gold in Europe in the time of Aurelian, whose empress had to forego the luxury of a silk gown on account of its cost.* Through Constantinople and Italy the manufacture passed slowly westward, and was not established in France until the sixteenth century, and arrived at a still later period in this country. It is related that James V. had to borrow a pair of silk hose from the Earl of Mar, in order that he might not, as he expressed it, appear as a scrub before strangers.

So cotton, of which the manufacture in India dates from before historical times, had scarcely by the Christian Era reached Persia and Egypt. Spain in the tenth, and Italy in the fourteenth century manufactured it, but Manchester, which is now the great metropolis of the trade, not until the latter half of the seventeenth century.

Linen was worn by the old Egyptians, and some of their linen mummy-cloths surpass in fineness any linen fabrics made in later days.† The Babylonians wore linen also, and wool, and obtained a widespread fame for skill in workmanship and beauty in design.

In this country wool long formed the staple for clothing. Silk was the first rival, but its costliness placed it beyond the reach of the many. To introduce a new material or improved machine into this or other countries a century or more ago was no light undertaking. Inventors, and would-be benefactors, alike ran the risk of loss of life. Loud was the outcry made in the early part of the eighteenth century agai nst the introduction of Indian cottons and Dutch calicoes.

Until 1738, in which year the improvements in spinning machinery were begun, each thread of worsted or cotton-wool had been spun between the fingers in this and all other countries. Wyatt, in 1738, invented spinning by rollers instead of fingers, and his invention was further improved by Arkwright. In 1770 Hargreaves patented the spinning jenny and Crompton the mule in 1775, a machine which combined the advantages of the frames of both Hargreaves and Arkwright. In less than a century after the first invention by Wyatt, double mules were working in Manchester with over 2000 spindles. Improvements in machines for weaving were begun at an earlier date. In 1579 a ribbon loom is said to have been invented at Dantzic, by which from four to six pieces could be woven at one time, but the machine was destroyed and the inventor lost his life.* In 1800 Jacquard's most ingenious invention was brought into use, which, by a simple mechanical operation, determines the movements of the threads which form the pattern in weaving. But the greatest discovery in the art of weaving was wrought by Cartwright's discovery of the power loom, which led eventually to the substitution of steam for manual labour, and enabled a boy with a steam loom to do fifteen times the work of a man with a hand loom.

For complex ingenuity few machines will compare with those used in the manufacture of lace and bobbin net. Hammond, in 1768, attempted to adapt the stocking frame to this manufacture, which had hitherto been conducted by hand. It remained for John Heathcoat to complete the adaptation in 1809, and to revolutionise this branch of industry, reducing the cost of its produce to one-fortieth of what the cost had been before Heathcoat's improvements were effected.

Most of these ingenious machines were in use before Watt's genius gave the world a new motive power in the steam-engine; and, had the steam-engine never been perfected, they would still have enormously increased the productive power of mankind. Water power was applied to many of them; in the first silk-thread mill erected at Derby in 1738, 318 million yards of silk thread were spun daily with one water-wheel.

These are happier times for inventors: keen competition among manufacturers does not let a good invention lie idle now. That which was rejected by old machines as waste is now worked up into useful fabrics by new ones. From all parts of the world new products come—jute from India, flax from New Zealand, and many others which demand new adaptations of old machines or new and untried mechanical arrangements to utilise them. Time would fail me if I were to attempt to enumerate one tithe of these rare combinations of mechanical skill; and, indeed, no one will ever appreciate the labour and supreme mental effort required for their construction who has not himself seen them and their wondrous achievements.

Steamboats, the electric telegraph, and railways, are more within the cognisance of the world at large, and the progress that has been made in them in little more than one generation is better known and appreciated.

It is not more than forty years since one of our scientific men, and an able one too, declared at a meeting of this Association that no steamboat would ever cross the Atlantic; founding his statement on the impracticability, in his view, of a steamboat carrying sufficient coal, profitably, I presume, for the voyage. Yet, soon after this statement was made, the *Sirius* steamed from Bristol to New York in seventeen days,† and was soon followed by the *Great Western* which made the homeward passage in thirteen-and-a-half days; and with these voyages the era of steamboats began. Like most important inventions, that of the steamboat was a long time in assuming a form capable of being profitably utilised; and even when it had assumed such a form, the

* Manufacture of silk brought from China to Constantinople A.D. 522.

† Wilkinson's "Ancient Egyptians;" Pliny, Book xix., c. ii.

* Beckman's "History of Inventions," vol. ii., p. 528.

† First steamer crossed the Atlantic by steam alone in 1838.

objections of commercial and scientific men had still to be overcome.

Among the many names connected with the early progress in the construction of steamboats, perhaps none is more worthy of remembrance than that of Patrick Miller, who, with the assistance of Symington, an engineer, and Taylor, who was his children's tutor, constructed a small steamboat. Shortly afterwards Lord Dundas, who saw the value of the application of steam for the propulsion of boats, had the first really practical steamboat constructed with a view to using it on the Forth and Clyde Canal. The proprietors, however, objected, and the boat lay idle. Again, another attempt to make practical use of the steamboat failed through the death of the Duke of Bridgewater, who, with his characteristic foresight, had seen the value of steam as a motive power for boats, and had determined to introduce steamboats on the canal which bears his name.

The increase in the number of steamboats since the time when the *Sirius* first crossed the Atlantic has been very great. Whereas in 1814 the United Kingdom only possessed two steam vessels, of together 456 tons burden, in 1872 there were on the register of the United Kingdom 3662 steam vessels, of which the registered tonnage amounted to over a million and a half of tons,* or to nearly half the whole steam tonnage of the world, which did not at that time greatly exceed three million tons.

As the number of steamboats has largely increased, so also gradually has their size increased until it culminated in the hands of Brunel in the *Great Eastern*.

A triumph of engineering skill in ship-building, the *Great Eastern* has not been commercially so successful. In this, as in many other engineering problems, the question is not how large a thing can be made, but how large, having regard to other circumstances, it is proper at the time to make it.

If, as regards the dimensions of steamboats, we have at present somewhat overstepped the limits in the *Great Eastern* much still remains to be done in perfecting the form of vessels, whether propelled by steam or driven by the force of the wind. A distinguished member of this Association, Mr. Froude, has now for some years devoted himself to investigations carried on with a view to ascertain the form of vessel which will offer the least resistance to the water through which it must pass. So many of us in these days are called upon to make journeys by sea as well as by land, that we can well appreciate the value of Mr. Froude's labours, so far as they tend to curtail the time which we must spend on our ocean journeys; and we should all feel grateful to him if from another branch of his investigations, which relates to the rolling of ships, it should result that the movement in passenger vessels could be reduced. A gallant attempt in this direction has lately been made by Mr. Bessemer; whether a successful one yet remains to be proved. In any event, he and those who have acted with him deserve our praise for an experiment which must add to our knowledge.

It is a question of vital importance to the steamboat that the consumption of fuel should be reduced to the smallest possible amount, inasmuch as each ton of fuel excludes a ton of cargo.

As improvements in the form of the hull are effected, less power—that is, less fuel—will be required to propel the vessel through the water for a given distance. Great as have been the improvements effected in marine engines to this end, much still remains to be done. Wolf's compound engine, so long overlooked, is, with some improvements, being at last applied. Whereas the consumption of fuel in such vessels as the *Himalaya* used to be from 5 to 6 lbs. of fuel per effective horse-power, it has been reduced, by working steam more expansively in vessels of a later date, to 2 lbs. Yet, comparing this with the total amount of energy of 2 lbs. of coal, it will be found that not a tenth part of the power is obtained which that amount of coal would theoretically call into action.*

* Board of Trade Return, July 15, 1874, Table 8.

We live in an age when great discoveries are made, and when they are speedily taken advantage of if they are likely to be of service to mankind.

In former times, man's inventions were frequently in advance of the age, and they were laid aside to await a happier era. There were in those earlier days too few persons who cared to, or who could, avail themselves of the proffered boon, and there was no sufficient accumulation of wealth to justify its being appropriated to schemes which are always in their early stage more or less speculative.

There is no more remarkable instance of the rapid utilisation of what was in the first instance regarded by most men as a mere scientific idea, than the adoption and extension of the electric telegraph.

Those who read Odier's letter written in 1773, in which he made known his idea of a telegraph which would enable the inhabitants of Europe to converse with the Emperor of Mogul, little thought that in less than a century a conversation between persons at points so far distant would be possible. Still less did those who saw in the following year messages sent from one room to another by Lesage in the presence of Friedrich of Prussia, realise that they had before them the germ of one of the most extraordinary inventions among the many that will render this century famous.

I should weary you were I to follow the slow steps by which the electric telegraph of to-day was brought to its present state of efficiency. In the present century few years have passed without new workers appearing in the field; some whose object was to utilise the new-found power for the benefit of mankind, others—and their work was not the least important in the end—whose object was to investigate magnetism and electrical phenomena as presenting scientific problems still unsolved. Galvani, Volta, Oersted, Arago, Sturgeon, and Faraday, by their labours, helped to make known the elements which rendered it possible to construct the electric telegraph. With the battery, the electric coil, and the electro-magnet, the elements were complete, and it only remained for Sir Charles Wheatstone and others to combine them in a useful and practically valuable form. The inventions of Alexander Stenheil, and those of similar nature to that of Sir Charles Wheatstone, were made known at a later date in the same year, which will ever be memorable in the annals of telegraphy.†

The first useful telegraph was constructed upon the Blackwall Railway in 1838, Messrs. Wheatstone's and Cooke's instruments being employed. From that time to this the progress of the electric telegraph has been so rapid, that at the present time, including land lines and submarine cables, there are in use in different parts of the world not less than 400,000 miles of telegraph.

* Theroretical Energy of 1 lb. of Coal:—

The proportions of heat expended in generating saturated steam at 212° F., and at 14·7 lbs. pressure per square inch, from water at 212° are:

	Units of heat.	Mechanical equivalent in foot-lbs.
I. In the formation of steam ..	892·8	689,242
II. In resisting the incumbent pressure of 14·7 lbs. per sq. inch..	72·3	55,815
	965·1	745,057

One pound of Welsh coal will theoretically evaporate 15 lbs. of water at 212° to steam at 212°. Therefore, the full theoretical value of the combustion of 2 lbs. of Welsh coal is

$$2 \times 15 \times 745{,}057 \text{ foot-pounds,}$$

or

$$\frac{2 \times 15 \times 745{,}057}{60 \times 33{,}000} \text{ horse-power, if consumed in 1 hour.}$$

$$= 11{\cdot}2 \text{ horse-power.}$$

As the consumption of coal per effective horse-power in a marine engine is 2 lbs., the power obtained is to the whole theoretical power as 1 is to 11.

† Dates of patents: Wheatstone, March 1, 1837; Alexander, April 22, 1837; Steinheil, July 1, 1837; Morse, October, 1837.

Among the numerous inventions of late years, the automatic telegraph of Mr. Alexander Bain, of Dr. Werner Siemens, and of Sir Charles Wheatstone, are especially worthy of notice. Mr. Bain's machine is chiefly used in the United States, that of Dr. Werner Siemens in Germany. In this country the machine invented by Sir Charles Wheatstone, to whom telegraphy owes so much, is chiefly employed. By his machine, after the message has been punched out in a paper ribbon by one machine on a system analogous to the dot and dash of Morse, the sequence of the currents requisite to transmit the message along the wire is automatically determined in a second machine by this perforated ribbon. The second operation is analogous to that by which in Jacquard's loom the motions of the threads requisite to produce the pattern is determined by perforated cards. By Wheatstone's machine errors inseparable from manual labour are avoided; and what is of even more importance in a commercial point of view, the time during which the wire is occupied in the transmission of a message is considerably diminished.

By the application of these automatic systems to telegraphy, the speed of transmission has been wonderfully accelerated, being equal to 200 words a minute, that is, faster than a shorthand writer can transcribe; and, in fact, words can now be passed along the wires of land lines with a velocity greater than can be dealt with by the human agency at either end.

Owing partly to the retarded effects of induction and other causes, the speed of transmission by long submarine cables is much smaller. With the cable of 1858 only 2½ words per minute were got through. The average with the Atlantic cable, Dr. C. W. Siemens informs me, is now 17 words, but 24 words per minute can be read.

One of the most striking phenomena in telegraphy is that known as the duplex system, which enables messages to be sent from each end of the same wire at the same time. This simultaneous transmission from both ends of a wire was proposed in the early days of telegraphy, but, owing to imperfect insulation, was not then found to be practicable; but since then telegraphic wires have been better insulated, and the system is now becoming of great utility, as it nearly doubles the capacity for work of every wire.

And yet within how short a period of time has all the wonderful progress in telegraphy been achieved! How incredulous the world a few years ago would have been if then told of the marvels which in so short a space of time were to be accomplished by its agency!

It is not long ago—1823—that Mr., now Sir Francis Ronalds, one of the early pioneers in this field of science, published a description of an electric telegraph. He communicated his views to Lord Melville, and that nobleman was obliging enough to reply that the subject should be inquired into; but before the nature of Sir Francis Ronalds's suggestions could be known, except to a few, that gentleman received a reply from Mr. Barrow, 'that telegraphs of any kind were then wholly unnecessary, and that no other than the one then in use would be adopted;' the one then in use being the old semaphore, which, crowning the tops of the hills between London and Portsmouth, seemed perfection to the Admiralty of that day.

I am acquainted with some who, when the first Transatlantic cable was proposed, contributed towards that undertaking with the consciousness that it was only an experiment, and that subscribing to it was much the same thing as throwing their money into the sea. Much of this cable was lost in the first attempt to lay it; but its promoters, nothing daunted, made 900 miles more cable, and finally laid it successfully in the following year, 1858.

The telegraphic system of the world comprises almost a complete girdle round the earth; and it is probable that the missing link will be supplied by a cable between San Francisco in California and Yokohama in Japan.

How resolute and courageous those who engaged in submarine telegraphy have been will appear from the fact that, though we have now 50,000 miles of cable in use, to get at this result nearly 70,000 miles were constructed and laid. This large percentage of failure, in the opinion of Dr. C. W. Siemens (to whom I am much indebted for information on this subject), was partly due to the late introduction of testing a cable under water before it is laid, and to the use of too light iron sheathing.

Of immense importance in connection with the subsequent extension of submarine cables have been the discoveries of Ohm and Sir William Thomson, and the knowledge obtained that the resistance in wire of homogeneous metal is directly proportional to the length, so that the place of a fault in a cable of many thousand miles in length can be ascertained with so much precision as to enable you to go at once to repair it, although the damaged cable may lie in some thousands of fathoms of water.

Of railways the progress has been enormous; but I do not know that in a scientific point of view a railway is so marvellous in its character as the electric telegraph. The results, however, of the construction and use of railways are more extensive and wide spread, and their utility and convenience brought home to a larger portion of mankind. It has come to pass, therefore, that the name of George Stephenson has been placed second only to that of James Watt; and as men are and will be estimated by the advantages which their labours confer on mankind, he will remain in that niche, unless indeed some greater luminary should arise to outshine him. The merit of George Stephenson consisted, among other things, in this, that he saw more clearly than any other engineer of his time the sort of thing that the world wanted, and that he persevered in despite of learned objectors with the firm conviction that he was right and they were wrong, and that there was within himself the power to demonstrate the accuracy of his convictions.

Railways are a subject on which I may (I hope without tiring you) speak somewhat more at length. The British Association is peripatetic, and without railways its meetings, if held at all, would, I fear, be greatly reduced in numbers. Moreover, you have all an interest in them: you all demand to be carried safely, and you insist on being carried fast. Besides, everybody understands, or thinks he understands, a railway, and therefore I shall be speaking on a subject common to all of us, and shall possibly only put before you ideas which others as well as myself have already entertained.

We who live in these days of roads and railways, and can move with a fair degree of comfort, speed, and safety, almost where we will, can scarcely realise the state of England two centuries ago, when the years of opposition which preceded the era of coaches began; when, as in 1662, there were but six stages in all England, and John Crossdell, of the Charterhouse, thought there were six too many; when Sir Henry Herbert, a member of the House of Commons, could say, 'If a man were to propose to carry us regularly to Edinburgh in coaches in seven days, and bring us back in seven more, should we not vote him to Bedlam?

In spite of short-sighted opposition, coaches made their way; but it was not until a century later, in 1784—and then I believe it was in this city of Bristol—that coaches were first established for the conveyance of mails. Those here who have experienced, as I have, what the discomforts were of long journeys inside the old coaches, will agree with me that they were very great; and I believe, if returns could be obtained of the accidents which happened to coaches, it would be found that many more people were injured and killed in proportion to the number that travelled by that mode, than by the railways of to-day.

No sooner had our ancestors settled down with what comfort was possible in their coaches, well satisfied that twelve miles an hour was the maximum speed to be obtained or that was desirable, than they were told that steam conveyance on iron railways would supersede their

'present pitiful' methods of conveyance. Such was the opinion of Thomas Gray, the first promoter of railways, who published his work on a general iron railway in 1819. Gray was looked on as little better than a madman. 'When Gray first proposed his great scheme to the public,' said Chevalier Wilson, in a letter to Sir Robert Peel in 1845, 'people were disposed to treat it as an effusion of insanity.' I shall not enter on a history of the struggles which preceded the opening of the first railway. They were brought to a successful issue by the determination of a few able and far-seeing men. The names of Thomas Gray and Joseph Sandars, of William James and Edward Pease, should always be remembered in connection with the early history of railways, for it was they who first made the nation familiar with the idea. There is no fear that the name of Stephenson will be forgotten, whose practical genius made the realisation of the idea possible.

The Stockton and Darlington Railway was opened in 1825, the Liverpool and Manchester Railway in 1830, and in the short time which has since elapsed, railways have been extended to every quarter of the globe. No nation possessing wealth and population can afford to be without them; and though at present in different countries there is in the aggregate about 160,000 miles of railway, it is certain that in the course of a very few years this quantity, large as it is, will be very greatly exceeded.

Railways add enormously to the national wealth. More than 25 years ago it was proved to the satisfaction of a committee of the House of Commons, from facts and figures which I then adduced, that the Lancashire and Yorkshire Railway, of which I was the engineer, and which then formed the principal railway connection between the populous towns of Lancashire and Yorkshire, effected a saving to the public using the railway of more than the whole amount of the dividend which was received by the proprietors. These calculations were based solely on the amount of traffic carried by the railway, and on the difference between the railway rate of charge and the charges by the modes of conveyance anterior to railways. No credit whatever was taken for the saving of time, though in England pre-eminently time is money.

Considering that railway charges on many items have been considerably reduced since that day, it may be safely assumed that the railways in the British Islands now produce, or rather save to the nation, a much larger sum annually than the gross amount of all the dividends payable to the proprietors, without at all taking into account the benefit arising from the saving in time. The benefits under that head defy calculation, and cannot with any accuracy be put into money; but it would not be at all over-estimating this question to say that in time and money the nation gains at least what is equivalent to 10 per cent. on all the capital expended on railways. I do not urge this on the part of railway proprietors, for they did not embark in these undertakings with a view to the national gain, but for the expected profit to themselves. Yet it is as well it should be noted, for railway proprietors appear sometimes by some people to be regarded in the light of public enemies.

It follows from these facts that whenever a railway can be made at a cost to yield the ordinary interest of money, it is in the national interest that it should be made. Further, that though its cost might be such as to leave a smaller dividend than that to its proprietors, the loss of wealth to so small a section of the community will be more than supplemented by the national gain, and therefore there may be cases where a government may wisely contribute in some form to undertakings which, without such aid, would fail to obtain the necessary support.

And so some countries, Russia for instance, to which improved means of transport are of vital importance, have wisely, in my opinion, caused lines to be made which, having regard to their own expenditure and receipts, would be unprofitable works, but in a national point of view are, or speedily will be, highly advantageous.

The Empire of Brazil also, which I have lately visited, is arriving at the conclusion, which I think not an unwise one, that the State can afford and will be benefited in the end by guaranteeing 7 per cent. upon any railway that can of itself be shown to produce a net income of 4 per cent., on the assumption that the nation will be benefited at least to the extent of the difference.

A question more important probably in the eyes of many—safety of railway travelling—may not be inappropriate. At all events, it is well that the elements on which it depends should be clearly understood. It will be thought that longer experience in the management of railways should go to ensure greater safety, but there are other elements of the question which go to counteract this in some degree.

The safety of railway travelling depends on the perfection of the machine in all its parts, including the whole railway, with its movable plant, in that term; it depends also on the nature and quantity of traffic, and lastly, on human care and attention.

With regard to what is human, it may be said that so many of these accidents as arise from the fallibility of men will never be eliminated until the race be improved.

The liability to accident will also increase with the speed, and might be reduced by slackening that speed. It increases with the extent and variety of the traffic on the same line. The public, I fear, will rather run the risk than consent to be carried at a slower rate. The increase in extent and variety of traffic is not likely to receive any diminution; on the contrary, it is certain to augment.

I should be sorry to say that human care may not do something, and I am not among those who object to appeals through the press, and otherwise to railway companies, though sometimes perhaps they may appear in an unreasonable form. I see no harm in men being urged in every way to do their utmost in a matter so vital to many.

A question may arise whether, if the railways were in the hands of the Government, they could not be worked with greater safety. Government would not pay their officers better, or perhaps so well as the companies do, and it is doubtful whether they would succeed in attracting to the service abler men. They might do the work with a smaller number of chief officers, for much of the time of the companies' managers is occupied in internecine disputes. They might handle the traffic more despotically, diminishing the number of trains, or the accommodation afforded by them, or in other ways, to insure more safety; but would the public bear any curtailment of convenience?

One thing they could, and perhaps would do. In cases where the traffic is varied, and could more safely be conducted with the aid of relief lines, which hold out no sufficient inducement to the companies to make, the Government, being content with a lower rate of interest, might undertake to make them, though then comes the question whether, when the whole of this vast machine came to depend for supplies on annual votes of Parliament, money would be forthcoming in greater abundance than it is under the present system.

But the consideration of this subject involves other and more difficult questions.

Where are the labours of Government to stop? The cares of State which cannot be avoided are already heavy, and will grow heavier every year. Dockyard establishments are trifling to what the railway establishments, which already employ 250,000 men, would be. The assumption of all the railways would bring Government into conflict with every passenger, every trader, every merchant, and every manufacturer. With the railway companies there would be no difficulty; they would sell their undertakings to anyone provided their price was ample.

Looking at the vast growth of railway traffic, one measure occurs to me as conducive to the safety of rail-

way passengers, and likely to be demanded some day: it is to construct between important places railways which should carry passengers only or coals only, or be set apart for some special separation of traffic; though there will be some difficulty in accomplishing this. Landowners, through whose properties such lines would pass, would probably wish to use such lines for general purposes. Nevertheless, it may have to be tried some day.

It would be instructive, were it practicable, to compare the relative proportion of accidents by railway and by the old stage coaches, but no records that I am aware of exist of the latter that would enable such a comparison to be made. It is practicable to make some sort of comparison between the accidents in the early days of our own railways and the accidents occurring at a later date.

The Board of Trade have unfortunately abandoned the custom, which they adopted from 1852 to 1859, of returning the passenger mileage, which is given in the German returns, and is the proper basis upon which to found the proportion of accidents, and not on the number of passengers without any regard to distance travelled, which has altered very much, the average journey per passenger being nearly half in 1873 what it was in 1846.

It would be erroneous to compare the proportions of accidents to passengers carried in various years, even if the correct number of passengers travelling were given. But a figure is always omitted from the Board of Trade return, which makes the proportion of accidents to passengers appear larger than it is; this is the number of journeys performed by season-ticket holders. Some estimate could be made of the journeys of season-ticket holders by dividing the receipts by an estimated average fare, or the companies could make an approximate estimate, and the passenger mileage could be readily obtained by the railway companies from the tickets. These additions would greatly add to the value of the railway returns as statistical documents, and render the deductions made from them correct.

Though it has been a work of labour, I have endeavoured to supply these deficiencies, and I believe the results arrived at may be taken as fairly accurate.

From the figures so arrived at, it appears the passenger mileage has doubled between 1861 and 1873; and at the rate of increase between 1870 and 1873 it would become double what it was in 1873 in twelve years from that time, namely in 1885.

The number of passengers has doubled between 1864 and 1873, and at the rate of increase between 1870 and 1873 it would become double what it was in 1873 in eleven-and-a-half years, or in 1885.

It must, however, be remembered that the rate of increase since 1870, though very regular for 1871, 1872, and 1873, is greater than in previous years, being probably due to the rise of wages and the great development of third-class traffic, and it would not be safe to assume this rate of increase will continue.

Supposing no improvement had been effected in the working of railway traffic, by the interlocking of points, the block system, &c., the increase of accidents should have borne some proportion to the passenger mileage, multiplied by the proportion between the train mileage and the length of line open, as the number of trains passing over the same line of rails would tend to multiply accidents in an increasing proportion, especially where the trains run at different speeds.

The number of accidents varies considerably from year to year, but, taking two averages of ten years each, it appears that the proportion of deaths of passengers from causes beyond their control to passenger miles travelled in the ten years ending December 31, 1873, was only two-thirds of the same proportion in the ten years ending December 31, 1861; the proportion of all accidents to passengers from causes beyond their own control was one-ninth more in the last ten years than in the earlier, whereas the frequency of trains had increased, on the average, one-fourth.

The limit, however, of considerable improvements in signalling, increased brake power, &c., will probably be reached before long, and the increase of accidents will depend on the increase of traffic, together with the increased frequency of trains.

The large growth of railway traffic, which we may assume will double in twenty years, will evidently greatly tax the resources of the railway companies; and unless the present companies increase the number of lines of way, as some have commenced to do, or new railways are made, the system of expeditious and safe railway travelling will be imperilled. Up to the present time, however, the improvements in regulating the traffic appear to have kept pace with the increase of traffic and of speed, as the slight increase in the proportion of railway accidents to passenger miles is probably chiefly due to a larger number of trifling bruises being reported now than formerly.

I believe it was a former President of the Board of Trade who said to an alarmed deputation, who waited upon him on the subject of railway travelling, that he thought he was safer in a railway carriage than anywhere else.

If he gave any such opinion, he was not far wrong, as is sufficiently evident when it can be said that there is only one passenger injured in every four million miles travelled, or that, on an average, a person may travel 100,000 miles each year for forty years, and the chances be slightly in his favour of his not receiving the slightest injury.

A pressing subject of the present time is the economy of fuel. Members of the British Association have not neglected this momentous question.

At the meeting held at Newcastle-on-Tyne in 1863, Sir William Armstrong sounded an alarm as to the proximate exhaustion of our coal-fields.

Mr. Bramwell, when presiding over the Mechanical Section at Brighton, drew attention to the waste of fuel.

Dr. Siemens, in an able lecture he delivered by request of the Association to the operative classes at the meeting at Bradford, pointed out the waste of fuel in special branches of the iron trade, to which he has devoted so much attention.

He showed on that occasion that, in the ordinary reheating furnace, the coal consumed did not produce the twentieth part of its theoretical effect, and in melting steel in pots in the ordinary way not more than one-seventieth part; in melting one ton of steel in pots about 2½ tons of coke being consumed. Dr. Siemens further stated that, in his regenerative gas furnace, one ton of steel was melted with 12 cwts. of small coal.

Mr. Lowthian Bell, who combines chemical knowledge with the practical experience of an ironmaster, in his Presidential address to the members of the Iron and Steel Institute in 1873, stated that, with the perfect mode of withdrawing and utilising the gases and the improvement in the furnaces adopted in the Cleveland district, the present make of pig-iron in Cleveland is produced with 3½ million tons of coal less than would have been needed fifteen years ago; this being equivalent to a saving of 45 per cent of the quantity formerly used. He shows, by figures with which he has favoured me, that the calorific power of the waste gases from the furnaces is sufficient for raising all the steam and heating all the air the furnaces require.

It has already been stated that, by working steam more expansively, either in double or single engines, the consumption of fuel in improved modern engines compared with the older forms may be reduced to one-third.

All these reductions still fall far short of the theoretical effect of fuel which may be never reached. Mr. Lowthian Bell's figures go to show that in the interior of the blast furnace, as improved in Cleveland, there is not much more to be done in reducing the consumption of fuel; but much has already been done, and could the reductions now attainable, and all the information already acquired,

be universally applied, the saving in fuel would be enormous.

How many open blast furnaces still belch forth flame and gas and smoke as uselessly, and with nearly as much mischief to the surrounding neighbourhood, as the fires of Etna or Vesuvius?

How many of the older and more extravagant forms of steam-engine still exist?

What is to be done with the intractable householder with the domestic hearth, where, without going to German stoves, but by using Galton's grates and other improvements, everything necessary both for comfort and convenience could be as well attained with a much smaller consumption of coal?

If I have pointed out that we do not avail ourselves of more than a fractional part of the useful effects of fuel, it is not that I expect we shall all at once mend our ways in this respect.

Many cases of waste arise from the existence of old and obsolete machines, of bad forms of furnaces, of wasteful grates, existing in most dwelling-houses; and these are not to be remedied at once, for not everyone can afford, however desirable it might be, to cast away the old and adopt the new.

In looking uneasily to the future supply and cost of fuel, it is, however, something to know what may be done even with the application of our present knowledge; and could we apply it universally to-day, all that is necessary for trade and comfort could probably be as well provided for by one-half the present consumption of fuel; and it behoves those who are beginning to build new mills, new furnaces, new steamboats, or new houses, to act as though the price of coal which obtained two years ago had been the normal, and not the abnormal price.

There was in early years a battle of the gauges, and there is now a contest about guns; but your time will not permit me to say much on their manufacture.

Here, again, the progress made in a few years has been enormous; and in contributing to it, two men, Sir William Armstrong and Sir Joseph Whitworth, both civil engineers, in this country at all events, deservedly stand foremost. The iron coil construction of Sir William Armstrong has already produced remarkable and satisfactory results; in discussing further possible improvements, the question is embarrassed by attempting to draw sharp lines between what is called steel and iron.

There is nothing that I can see to limit the size of guns, except the tenacity and endurance of the metal, whatever we may choose to call it, of which they are to be made.

Sir Joseph Whitworth, who has already done more than any other man in his department to secure good workmanship, and whose ideal of perfection is ever expanding, has long been seeking, and not without success, by enormous compression, to increase those qualities in what he calls homogeneous metal. Make the metal good enough, and call it iron if you will, and the size of a gun may be anything: the mere construction and handling of a gun of 100 tons, or of far greater weight, with suitable mechanical appliances, presents no difficulty.

Relying on the qualities of his compressed metal, Sir Joseph is now seeking, by a singular experiment, to limit the travel of the recoil, as far as practicable, to the elasticity of the metal. By attaching the muzzle of the gun to an outer casing, through which the force of the recoil is carried back to the trunnions, he proposes to avail himself of this elasticity to the extent of one-and-a-half times the length of the gun; whether its elasticity alone in so short a space will suffice without other aid is, perhaps, doubtful; but other aid may be applied, and the experiment, whether successful or not, will be interesting.

Docks and harbours I have no time to mention, for it is time this long and, I fear, tedious address, should close.

"Whence and whither" is an aphorism which leads us away from present and plainer objects to those which are more distant and obscure; whether we look backwards or forwards, our vision is speedily arrested by an impenetrable veil.

On the subjects I have chosen you will probably think I have travelled backwards far enough. I have dealt to some extent with the present.

The retrospect, however, may be useful to show what great works were done in former ages.

Some things have been better done than in those earlier times, but not all.

In what we choose to call the ideal we do not surpass the ancients. Poets and painters and sculptors were as great in former times as now; so, probably, were the mathematicians.

In what depends on the accumulation of experience, we ought to excel our forerunners. Engineering depends largely on experience; nevertheless, in future times whenever difficulties shall arise or works have to be accomplished for which there is no precedent, he who has to perform the duty may step forth from any of the walks of life, as engineers have not unfrequently hitherto done.

The marvellous progress of the last two generations should make everyone cautious of predicting the future. Of engineering works, however, it may be said that their practicability or impracticability is often determined by other elements than the inherent difficulty in the works themselves. Greater works than any yet achieved remain to be accomplished—not, perhaps, yet awhile. Society may not yet require them; the world could not at present afford to pay for them.

The progress of engineering works, if we consider it, and the expenditure upon them, has already in our time been prodigious. One hundred and sixty thousand miles of railway alone, put into figures at £20,000 a mile, amounts to 3200 million pounds sterling; add 400,000 miles of telegraph at £100 a mile, and 100 millions more for sea canals, docks, harbours, water and sanitary works constructed in the same period, and we get the enormous sum of 3340 millions sterling expended in one generation and a half on what may undoubtedly be called useful works.

The wealth of nations may be impaired by expenditure on luxuries and war; it cannot be diminished by expenditure on works like these.

As to the future, we know we cannot create a force; we can, and no doubt shall, greatly improve the application of those with which we are acquainted. What are called inventions can do no more than this; yet how much every day is being done by new machines and instruments!

The telescope extended our vision to distant worlds. The spectroscope has far outstripped that instrument, by extending our powers of analysis to regions as remote.

Postal deliveries were and are great and able organisations, but what are they to the telegraph?

Need we try to extend our vision into futurity farther? Our present knowledge, compared to what is unknown even in physics, is infinitesimal. We may never discover a new force—yet, who can tell?

DISTRIBUTION OF MAGNETISM IN BUNDLES OF VERY THIN PLATES OF FINITE LENGTH.

By JULES JAMIN.

My previous researches have had for their object the determination of, first the "Distribution of Magnetism in a Thin Plate of Great or Infinite Length,"* and then the distribution in a bundle composed of several such plates.† I now propose to study the general case in which the bundle has a *finite* length l.

* Electrical News, vol. i., pages 16 and 17.
† Electrical News, vol. i., page 52.

I have already in some old experiments shown that if a plate of steel of infinite length is attached to the extremity of a magnet, a magnetic curve of the same name is developed so that $y = A_n k_n^{-x}$: a general law of the magnetic distribution in plates long enough to be considered as infinite. But, if the bar is limited to a length $2l$, the equation becomes—

$$y = A_n(1 - k_n^{-2l})(k_n^{-x} - k_n^{-(2l-x)})$$

or by replacing A_n and k_n by their values—

$$v = A\sqrt{\frac{c+bc}{c+b}}\left(1 - k^{-2l}\sqrt{\frac{c+b}{c+bc}}\right)$$

$$\left(k^{-x}\sqrt{\frac{c+b}{c+bc}} - k^{-(2l-x)}\sqrt{\frac{c+b}{c+bc}}\right).$$

This formula has been completely verified by a very great number of experiments. It sums up the properties of magnetic bundles composed of very thin plates. It enables one to construct with certainty magnets containing a given quantity of magnetism or possessing a given strength at their extremity. It enables one to calculate the position of the poles, and the magnetic moment; it points out the magnet limit, and gives, in a word, the means of calculating all the questions which are to be met with in the use of magnets.

ON STATICAL ELECTRICITY AND SUPERFICIAL TENSION OF LIQUIDS.

In a memoir recently published, M. Van der Mensbrugghe inquires if statical electricity produces, like heat, variations in the contractile force of liquids. In the first part he gives a *resumé* of researches, preceding his own, which have treated of the relation of static electricity, if not to superficial tension, at least to the cohesion of liquids, which is intimately connected with the contractile force. He finds only two conclusions distinctly enunciated; the first by Erman and by M. Brunner, according to which static electricity exerts no action on the cohesion of a liquid; the second, affirmed by M. Plateau, that capillary forces do not undergo sensible diminution under the influence of electricity. From this it should follow that the tension of a good conducting liquid remains the same whether the liquid be electrified or not; and this is the conclusion to which the author is led by his experiments (described in the second part of the memoir), of which the following are the most important:—

A bubble of glycerine liquid, 6 to 8 centimetres in diameter, is deposited on an iron ring about 2 centimetres radius, supported on three feet, and placed below and at about 20 centimetres distance from the conductor of an electric machine. When the latter is electrified, one observes the effects that have been described by M. Cauderay in the case of soap bubbles; the liquid sheet elongates in the vertical direction, the curvature increases at the upper part, and decreases towards the base; and the more so as the charge becomes stronger. It is evident that then the quantity of electricity developed is greater at the summit than near the base of the film; consequently, if the electric fluid has an effect on the superficial tension, it is at the summit that the variation of this force will be most pronounced. Now, one does not observe in the film, either rapid descent of the liquid or attraction of the lower parts of the bubble towards the top; the colours appear in their usual way, even when a very strong charge is given to the conductor. The effects, then, are just as if the bubbles were forced mechanically to take the form described; and this would not alter their tension.

In order to see if the electric fluid would modify the contractile force of a full liquid mass, the author procured a U-tube of glass, the two branches of which were 12 centimetres in length; the internal diameter of the one was 10 m.m., that of the other only 1 m.m. Having dried the tube carefully, and well moistened the internal walls, he poured in a quantity of distilled water. In the narrow branch the column of water rose to about 27 m.m. above the level of the water in the wide branch. By electrification of the liquid in the latter, he did not produce, apparently, the least displacement of the column, even with very intense electric charges; whence he inferred that the electricity did not cause the tension of the liquid to vary.

If, instead of using a liquid of imperfect conductivity, the experiment be made with mercury, the effect is the same, there is no change through electrification.

Rigorously (M. Van der Mensbrugghe says) these facts might not appear conclusive; for if we electrify the water about the capillary tube, the tension, and consequently the molecular pressure due to the superficial layer of distilled water, might be altered without the capillary column diminishing in height. This was the result of the following experiment by M. Duclaux:—A thin layer of alcohol or oil is poured on the water surrounding a capillary tube, and no change is observed in the height of the column raised. To refute this objection M. Mensbrugghe first endeavours to show that M. Duclaux's experiment may be easily explained by means of Laplace's theory properly interpreted; then that in the case of electrification of water, the conclusion previously stated is the most legitimate one.

He thought it interesting to ascertain if static electricity would influence the equilibrium of a liquid column suspended in a tube, the internal diameter of which was near the maximum limiting value determined by M. Duclaux. This physicist repeated before him one of his experiments with a tube 19·14 m.m. internal diameter; it chanced that the stability of the column was very weak, notwithstanding the difference in value between its diameter and the maximum value realisable, 19·85 m.m. The tube was closed at its upper end by a cork covered with gum-lac; this cork was traversed by a copper rod terminating without in a small ball, and prolonged into the interior of the tube to about 7 m.m. of the open section; the whole of the apparatus serving as support was insulated.

Immediately the liquid column was suspended, the author removed all neighbouring conductors which might have a disturbing action, and then connected the copper rod with the conductor of the electric machine. Notwithstanding the electrification, the weak stability of the column was perfectly preserved; but if any good conductor was brought near the terminal liquid layer, this was sufficient to make the water flow at once.

En resumé, it follows from my experiments that the superficial tension, either of a film, or of a full mass, of good conducting liquid, is not modified by static electricity.

But this conclusion includes implicitly another consequence which seems to me important. It is that static electricity, instead of being expanded in the interior of the extreme layer of good conducting bodies, is found, on the contrary, entirely exterior, and simply applied against the limiting surface of these bodies. Indeed, if, as is commonly believed, the electricity had its seat in the interior of the superficial layer of a good conducting liquid, how are we to suppose that the repulsive forces acting between the same molecules charged with the same electricity would not diminish the tension of the superficial layer? seeing it has been proved that this tension is modified by the slightest causes, such as a very small elevation of temperature. Besides, the mathematical theory of electrostatics leads us to conceive of electric layers distributed in conductors, as being exterior to the surface of these, but immediately applied to them.

NOTE ON SCHWENDLER'S DUPLEX.

By A. EDEN.

AT paragraph 13 of Mr. Johnston's communication on the above subject,* that gentleman states that "in all other known duplex methods, balancing the outgoing current at one station disturbs, invariably, the balance at the other station, and therefore if balance in any one station has once been disturbed, it can be regained only by successive adjustments in both stations."

Experience certainly does not verify this statement. If a station's artificial line resistance (either on the differential or bridge principle) is altered for adjusting purposes, its effect on the distant station is practically nil.

Even in telegraphic circles an impression prevails to the contrary, but experiments will confirm the statement just made.

The resistance (R) required at Station A is (on the differential principle) R of line + R of one coil of Station B's apparatus + joint R of B's sending battery, and artificial line + R of second coil of B's instrument, the alternation of the greater R in the joint resistance referred to, produces very little difference at Station A, and if not proportionately a very great alteration does not produce any effect whatever.

Suppose line and one coil of Station

B's apparatus	= R 1000
B's artificial line	= R 1200
B's second relay coil	= R 200
B's sending battery	= R 200

the R required by A would be—

$$\frac{1200 + 200 \times 200}{1200 + 200 + 200} + 1000 = 1175$$

A reduction of B's artifical line to 800 will reduce R required at A to 1167 only (neglecting fractions.) An increase of B's resistance to 1600 would raise A's required R to 1180 only.

Neither of these changes would probably be appreciable at A, so that practically no change at one station, which would not upset their own balance would produce any effect at the distant station beyond increasing or decreasing to a slight extent the deflection produced.

In duplexing, of course, Station A's current does not actually pass through Station B's instrument, but the resistance given is that which is necessary to effect balance at station A.

Paragraph 15 refers to a disposition of transmitting key, which was used by Stearns in 1873, when his apparatus was forwarded to this country, and provision is made in duplex circuits in the United Kingdom for the disconnecting interval alluded to.

Paragraphs 16 to 23 might be taken for a description of the *single current* duplexes in use here, and the arrangement referred to in Par. 27 has been adopted in this country since 1873. Mr. Stearns, indeed, adjusted his bridge system by altering the ratios of the arms as here proposed.

In Par. 28, it is recorded, "For duplex working about four times the battery power employed for single working is required."

In this country with lines inferior in insulation, and subject to considerable variation, the duplex sending power is never more than 50 per cent. above the ordinary power required for single working.

Whatever may be the merits of Mr. Schwendler's system, it cannot lay claim to novelty on any ground except the resistance proportions laid down in Paragraph 5.

* ELECTRICAL NEWS, vol. i., pp. 75, 89.

PNEUMATIC RELAY TELEGRAPHS FOR LONG DISTANCES.

PNEUMATIC tubes having proved signally important in a commercial point of view, and the demand for them increasing rapidly, engineers are beginning to enquire whether they cannot be profitably worked for longer distances than heretofore. The system has shown itself a most valuable auxiliary to telegraphy; and the probability of its still further increasing in importance in this branch of the Service induces us to give an abstract of a paper by M. Crespin, "On the Practicability of Profitably Working Tubes for Long Distances." The paper was read before the Paris Society of Civil Engineers in June last.

As far back as 1810 the idea of using atmospheric pressure as a means of conveying goods, &c., from one spot to another, was entertained by Medhurst, a Danish engineer, who was followed at a later date by an English engineer, advocating the same mode of transit, and employing for the purpose wooden tubes 6 feet in diameter.

A long interval elapsed before a fresh start was made to establish a pneumatic line. From 1834 to 1865 numerous suggestions were made, and, though they all appear to have failed in themselves, they undoubtedly proved stepping-stones to the attainment of greater results. Among the schemers were—an American engineer, Pinkus; Clegg and Samuda, Englishmen; Hallette d'Arras; Hediard and Arnollet; Zambaux; Mallat and Cralle, and others, who endeavoured to perfect the valves, which constituted the chief difficulty to be overcome. The most successful of the above inventors were Clegg and Samuda, who contrived a leathern valve which acted with sufficient regularity to enable them to effect transport by air pressure: their system lasted fourteen years, until 1852, when it was abandoned for a better one, invented six years earlier, viz., in 1846.

The inventors of this more perfect arrangement were Clark and Varley. They adopted a method analogous to that of Clegg and Samuda.

According to the Abbé Moigno, Ador made, in 1852, the first experiment of transmitting despatches by pressure of air, at the park of Monceau.

During the year 1854, Clark, in England, and Galy Cazelat, in France, took out a patent for a system of transmitting to a distance parcels and letters in tin tubes. Clark established, at the same time, at the central station in Telegraph Street, some short tubes worked in two directions, by means of a vacuum and pressure. This is the first instance we know of where *pressure* and *vacuum* were employed to drive forward and suck back the carrier.

A few years later—viz., in 1863—Varley completed Clark's improvement by adding a new system of valves of great value.

Lastly, in 1865, Siemens and Halske introduced tubes of a novel construction. For instance, a complete circuit formed by two tubes running side by side, joined at one end, and connected with the piston end. One pipe entered the piston at the upper, the other at the lower end; and by that means a current of air continually traversed the tube in one direction, suction and pressure aiding transport in the same direction. The pneumatic systems of Messrs. Clark and Varley, and Messrs. Siemens and Halske (with trifling improvements from other sources), are now the systems in use.

Mr. Sabine, according to *Engineering*, in 1874, concluded that the most economical results in working pneumatic tubes "will be found (1) from the employment of an entire 2½-inch lead system; (2) the pressures best suited for working are 10 lbs. pressure, 6½ lbs. vacuum for all lengths; (3) engine-power required—150 horse-power, of which not more than 30 per cent may be used in internal friction, &c., the remainder providing about 1200 cubic feet of compressed air and 2000 cubic feet of rarefied air per minute." From another source we learn that the

pressure in Clark's system may reach nearly 15 lbs. if necessary; but from a point of view of theoretical useful effect, and diminution of loss of air, *it is preferable to employ weak pressures* rather than those of high tension.

As far as has been estimated, from theoretical calculations, it is reckoned that the maximum that can be adopted with Clark's system of tubes, for *pressure* as the driving force, is 245 yards per horse-power; for *suction* as the drawing force, 179 yards. In practice various resistances must be taken into account, such as those arising for twists and turnings in the tube, which reduce the above figures by about 10 per cent.

Now it is evident that these limits are small, and become speedily inadequate as the demand for the pneumatic-conveying method increases. To a certain extent, from being purely an auxiliary to telegraphy, the system has entered into a brisk competition with it—competition in which, under certain conditions, it proves itself a powerful rival. One of the conditions is "short distances," where electricity becomes surpassed by this mode of transit of slower speed, but far greater transmitting capacity. To make this clearer, take the case of a wire 1000 yards long. The wire successively transmits the messages at the rate of 40 an hour; but the tube will carry 100 despatches in one minute. This likewise indicates how the advantage of pneumatic telegraphs diminishes as the number of messages lessens, and also in proportion as the distance between the two stations increases. Hence a distance is soon attained when the wire asserts its superiority over the tube.

Such being the case, Mr. Crespin enquires under what conditions the lengths of tube can be profitably worked, in excess of the limit hitherto assigned, in order to increase the efficiency of moderately long distances of pneumatic telegraphy over voltaic telegraphy.

After explaining that the difference of pressure between the engine current and that of the atmosphere, represented by $H-h$,* blows the carrier along, whilst $h-H$ sucks the carrier back again to its former position, the writer refers to the question which forms the subject of his communication, by first asking—"*What are the laws approximately governing the movement of carriers in pneumatic tubes?*" "Experiment," he says, "shows that the law observed in the flow of liquids can, without too much error, be applied to the flow of air in tubes. Calling R the resistance to movement, l length, x perimeter, u speed, and B two coefficients, the approximate formula of the flow of liquid is $R=lx(Au+Bu^2)$; and neglecting the term in which the speed is of the first degree, the formula becomes $R=Blxu^2$. The force which propels the carriers being equal to $H-h$ multiplied by the section S, the formula assumes the altered form of $(H-h)S=Blxu^2$; and when S is a circle—

$$H-h=\frac{8\,B\,lu^2}{D}, \text{ or } u=A\sqrt{\frac{(H-h)D}{l}}.$$

This shows that u, the speed, varies as the roots of all the conditions upon which the system is established,—directly for pressures and diameter, indirectly for length,—and experience has established the correctness of the formula.

Our study has reference to making a line, l, of as great a length as possible; and it therefore behoves us to examine successively the influence of each of the forces or dimensions in the above formula. First, as to the difference of motive pressure. The formula shows that if we increase in the same proportion $(H-h)$ and l, we obtain a constant speed. Unfortunately this simple solution is impossible; for practical means at our disposal do not admit of the compression of air at a sufficiently low cost price, beyond a certain extent—from about one effective atmosphere to two at the most. The second quantity in the formula is the diameter, which it is of course possible to increase; and if, therefore, we increase it in the same proportion as the length, a constant speed is maintained. This plan also is inapplicable on the score of expense,—because it would lead to the laying down of very large tubes, between far distant points, where traffic might be small; and because the cost of working a tube of increased dimensions augments very rapidly with the diameter—much faster than the square of the diameter. In laying a pneumatic line the only consideration to be taken into account in fixing the diameter of the tube is the amount of traffic to be created. A little thought will easily convince that it is not necessary to exceed a section which at first sight appears extremely small, in order to carry all possible increase of business, for a very large number of carriers can be passed through the tubes at a rapid rate.

* H equal engine pressure, and h that of the ordinary atmosphere.

Since pressure and diameter have been shown to have but very narrow limits, let us examine the influence of length itself.

The first researches on this subject date from 1857, and were made by Mr. Latimer Clark, who laid down the question of the necessity for a special mechanical arrangement whereby lines of a length relatively great could be worked by interposing a kind of vent-hole, which a special mechanism would close at the moment of the carriers' passage when traversing the line by pressure; and would be opened when suction was employed. Such an apparatus was devised by Mr. Sabine in 1860.

It consists of a valve regulated (by means of a handle-bar) by a sort of copper or india-rubber diaphragm upon which the pressure or suction of the central station acts by a special tube. This diaphragm, when pressure is used, opens the valve, and the air escaping by the vent-hole enables the carrier to clear the first section, as if the line was only as long as from the commencement to the vent-hole. Directly the carrier passes this vent-hole it detaches the valve from the handle-bar which joins it to the diaphragm; under the action of a spring the valve closes, and the carrier proceeds into the second section with the speed of a line equal in length to the first two sections, and so on. An inverse action takes place when the motive force is suction.

The following Table contains the effects of this apparatus in a hypothetical line of ten sections:—

Number of the Sections.	Time of Passage in Each Section.		Total Period of the Journey. With Valves.	Total Period of the Journey. Without Valves.		Relation of the two Times.
1		1	1		1	per cent.
2	$\sqrt{2}$	1·41	2·41	$2\sqrt{2}$	2·82	17·0
3	$\sqrt{3}$	1·73	4·14	$3\sqrt{3}$	5·19	25·4
4	$\sqrt{4}$	2·00	6·14	$4\sqrt{4}$	8·00	30·3
5	$\sqrt{5}$	2·24	8·38	$5\sqrt{5}$	11·20	33·7
6	$\sqrt{6}$	2·45	10·83	$6\sqrt{6}$	14·70	35·7
7	$\sqrt{7}$	2·65	13·48	$7\sqrt{7}$	18·55	37·6
8	$\sqrt{8}$	2·88	16·31	$8\sqrt{8}$	22·64	38·8
9	$\sqrt{9}$	3·00	19·31	$9\sqrt{9}$	27·00	39·8
10	$\sqrt{10}$	3·16	22·47	$10\sqrt{10}$	31·60	40·6

On inspecting the Table it is seen that the advantage ever increases in proportion as the line lengthens. This advantage, which is 17 per cent for two sections, rises to 40 per cent for ten sections. The remedy is, however, far from being radical, for though it allows the line to be lengthened, a limit must evidently soon be reached.

The solution of the problem is thus far unsolved. Mr. Crespin has invented an instrument which he calls a relay; its function is to replace an operator, who, placed in circumstances about to be described, would have to perform the following duties:—

Long pneumatic lines have been usually divided into sections of about 1000 yards. Each of these sections is supplied with reservoirs, in which compressed air is stored up: it having pressure and volume sufficient to serve the section. The duty of the operator is to attend to the carrier, which is sent him by letting the escapement of

air take place freely through the extremity of the section. At the instant when the carrier clears the space separating arrival line from the departure line, he closes behind it the departure line, and opens a stop-cock communicating with the reservoir of compressed air, which drives it through the following section of the line. He also keeps the cock open until communicated with by the operator at the next station.

Such an apparatus, we are informed, worked regularly for some months in France. The escapement of air took place in front of the relay, through a piece of tube perforated in every direction, and affording a passage equal to twice the section of the line. The closure of the line behind the carrier, and communication with the compressed air, was effected by a sort of trigger upon which the carrier acted as soon as it cleared the relay. The period of "blowing" was measured with a piston raised in a cylinder by means of the inner pressure; the law of this ascension being regulated by counter pressure in such a manner that the "blowing" lasted as long as the desired time. Directly the carrier reached its destination or entered into the continuing section, the pressure in the line fell, and the piston dropped.

The objection to the apparatus was its susceptibility. It encloses a delicate valve to close the line, and if a foreign body even partially opposes its working, the relay becomes itself an obstacle to the efficiency of the line.

To remedy this state of things it was necessary to suppress the valve, which, after the description just given, appeared to be the chief piece of the instrument. It could not be suppressed unless the escapement were suppressed; and the escapement could only be abolished at the expense of the counter pressure. This series of observations led to a project which has completely solved the question. The line is of double effect; by means of special apparatus which are really relays, it is constantly maintained empty of air, and consequently, the more compression, the more valves in the pressure relays.

The line, which we will suppose of illimited length, is escorted by two secondary pipes uniting with the suction and pressure reservoirs designed to supply the relays placed at convenient spots on the line.

These relays are of two kinds. Those whose object is to empty the line of air are placed at distances of 5 kilometres in those cases where the line will be traversed by carriers spaced by a quarter of an hour's interval. They are, moreover, extremely simple: a piston rising in a cylinder carries with it a valve closing the line and a slide opening the exhausting reservoirs. The piston is raised on the passage of a carrier by the action of the counter-pressure which follows it; it closes the line behind it, and immediately begins the exhaustion of the section just traversed. The valve borne by this relay is not subject to any of the inconveniences met with in those first invented.

The pressure relays are distant from each other 1 kilometre, and are simple "blowers," being opened on the carrier's passage, and blowing all the time the carrier is in their sections. They are merely formed of a piston carrying a counterpoise acting against a slide. The air enters the line through a kind of lantern (*lanterne*) studded with holes having twice the section of the line; and notice for blowing is given by the carrier itself, which, striking a detent, causes a counterpoise placed upon the piston and commanding the slide to fall. The blowing is instantaneous. It is suspended by the regulating piston's action, which closes the communication to line, and confines compressed air in a small chamber placed between this closer and slide. The effect of this compressed air at the moment when the pressure is lost in the line, *i.e.*, when the carrier has cleared the section, is to lift up the piston acting upon the slide and to put it in position for the arrival of the next carrier. This apparatus, which is the soul of the new system, is extremely simple and needs no supervision. It is accompanied by a reservoir of compressed air sufficient to serve its section.

There now remains but to examine the speed of a line furnished with these relay instruments. Let the line be 100 m.m. diameter, the suction-pressure be 50 centimetres of mercury, and the driving pressure be 76 centimetres of mercury. The comparison will be made between a line as above and the Parisian net-work, where a pressure of 40 centimetres of mercury gives a speed of 20 metres a second in a line 1000 metres long and 65 m.m. diameter.

The increase in diameter will augment the speed thus:—

$$\sqrt{\frac{100}{65}} \times 20 = 25 \text{ metres per second.}$$

The consideration that the line is constantly empty of air will reduce the friction-length of the sections of 1000 metres to a mean of 600 metres maximum; for, on entering each of the sections, *i.e.*, at the moment when the train clears the pressure relay, no column of air follows it, only at the end the column of air attains a length of 1000 metres. If exhaustion were absolute, the mean length of the friction column would be 500 metres. This diminution of the friction column gives a further increase of speed in the proportion of—

$$\sqrt{\frac{1000}{600}} \times 25 = \frac{33}{24} \times 25 = 34\frac{9}{24} \text{ metres per second.}$$

In addition to this, there is the augmentation resulting from the difference of pressures, which is likewise as the proportion of the roots—

$$\sqrt{\frac{76 \times 50}{40}} \times 34\frac{9}{24} = \frac{115}{65} \times 34\frac{9}{24} = 61 \text{ metres per second.}$$

This speed is enormous, and probably might create inconveniences. The observation of trains proceeding under analogous conditions, with speeds of 40 to 50 metres, has shown that these speeds are practically quite admissible in regular working. It is only necessary to have a material extremely solid, and so arranged as to wear itself out without wearing out the line; this has been provided for by furnishing the rubbing parts of the carriers with a much softer metal than that of the line.

Pneumatic relay lines will certainly eventually become valuable communicating engines for correspondences at distant spots. The facility with which trains or carriers may be multiplied on lines without considerable expenses, the rapidity with which they are capable of progressing, will render them grand systems if applied to the postal service, for their speed of translation is triple that of the most rapid locomotive, if stoppages on railways are taken into account.

Construction of Lightning-Conductors for Electric Telegraphs.—M. Schaack.—The ordinary arrangements are objectionable on account of complexity (and consequent danger), uncertainty, expense, and the fact that when *e.g.* the opposed cones get fused together by the lightning, repairs cannot be done by the person who works the apparatus, &c. M. Schaack's arrangement is briefly as follows:—On the two long sides of a tin case (about 10 c.m. square section), at the top, are fixed two insulating wooden bars which carry binding screws C and C'. C is connected with the line; and from C' a wire passes through the telegraph apparatus and to the outside of the case, which is connected with earth. The screws are connected together by a loosely wound spiral of German silver wire, the silk covering of which has been passed several times through a caoutchouc solution. The case is filled three-fourths with water. When lightning enters the line, the spiral, with its thin coating, offers it a nearly direct path through the water to earth. The windings act like the points of a cone, &c., in other arrangements. The spiral is either fused, or its envelope burst through; and in both cases, the way to the apparatus is broken and the lightning passes more directly to earth. After the storms, the attendant fits a reserve spiral in place of the one destroyed. The length of the case depends on the number of line wires.—*Dingler's Polytechnisches Journal.*

HISTORY OF MAGNETO-INDUCTION MACHINES WITH UNINTERRUPTED CURRENT OF INVARIABLE DIRECTION.*

(Concluded from page 88).

"Pacinotti also obtained an uninterrupted current of unvarying direction, when, during the rotation of the transversal electro-magnet, he brought near it the opposite poles of two permanent magnets, or magnetised the fixed electro-magnet with a current; the former he denotes as preferable. The same machine can be employed as well for transformation of the electric current into mechanical work, as for that of work into electricity."

Before the magneto-induction machine invented by Pacinotti (with a ring-formed core in the induction bobbin, rotating between two magnetic poles) had found any application, Dr. Werner Siemens, starting from the fact that every electro-magnetic machine produces in itself a contrary current increasing in strength with increased velocity of rotation, was led by theoretical considerations to the "dynamo-electric principle," which, in recent times, through its application to machines with ring-shaped core, has proved of the highest significance for these also. When the mechanician, H. Wilde, in Manchester, in the spring of 1866, had constructed a magneto-electric machine of surprising action, in which two of the cylinder inductors invented by Siemens in 1856 were employed, and in such a way that the one furnished with steel magnets was used only for continual magnetisation of the inducing electro-magnet of the other, he might have made himself quite independent of the unreliable action of the steel magnets, if he had used the current of the second inductor for magnetisation of the first. Wilde, however, did not reach this idea. On the other hand, Siemens experimented in December, 1866, before several Berlin physicists, with a one cylinder machine made according to the dynamo-electric principle, and without any steel magnets. In the beginning of 1867, Siemens read to the Berlin Academy, at its sitting of January 17, a paper (given in the reports for 1867, pp. 55-58) in which he shows how the currents induced by an electro-magnet can be utilised in strengthening the magnetism of the electro-magnet, and thereby again in strengthening the following induced current; that therefore even the small quantity of magnetism residual in the softest iron, is sufficient to produce an induction current of very quickly increasing strength. To the Paris Exhibition of 1867, Siemens and Halske sent a smaller and a larger one-cylinder dynamo-electric machine, while a large two-cylinder machine commenced in January, 1867, was not ready in time for the exhibition. Ladd, on the other hand, had, in May, 1867, sent the first completed two-cylinder dynamo-electric machine to the Exhibition in Paris. Both Wheatstone and Ladd used (in their dynamo-electric machines) the cylinder inductor of Dr. Siemens. The Siemens' machines have found extensive application in firing of mine chambers, and in bell-ringing mechanism.

As the dynamo-electric machine occupied the attention of the Royal Society in London, before which, on February 14, 1867, Dr. William Siemens exhibited and also read a paper on a small machine made in London, and also Prof. Wheatstone explained the construction of his machine, whereas it was on March 14, 1867, that Ladd made his first communication to the Society on his machine, the new magneto-induction machines also came into notice in the Paris Academy (*Comptes Rendus*, 1868) in which Gaiffe proposed to improve the Siemens machine, by replacing the two electro-magnets on one axis, used by Ladd, with one electro-magnet, having two bobbins near one another; an improvement, the priority of which Ruhmkorff claimed for Dr. Schellen. In France, however, where the *Nuovo Cimento* is not unknown, and where also Dr. Pacinotti, in a purely epistolary communication, made some extracts from his paper in 1865, when on his way to Paris, Z. T. Gramme gave the first incitement to replacing the permanent magnets acting on the transversal electro-magnet in Pacinotti's machine, by electro-magnets excited by the current of the machine itself, and so to the application of the electro-dynamic principle to that transversal electro-magnet. In this sense Gramme's machine is called (as Alfred Niaudet Breguet does in the most recent publication upon it—Paris, 1875—) "la première de son espèce." Gramme made the first communication to the Paris Academy on his machine at the seance of July 17, 1871; in this he himself says: "The horseshoe steel magnets used as exciters, might be replaced by electro-magnets, which *in the known way* might themselves be magnetised by a branch current of the machine; thus at the first, the remanent magnetism of the electro-magnet would induce only a weak current in the induction bobbin with massive ring-formed core, but the machine would soon come to its full force." The machine then exhibited to the Academy contained two electro-magnets with four poles acting on the ring core, and four rollers receiving the current; two of the latter send half of the current through the electro-magnets, while the two others furnish the current that is to be utilised outside. Each pair of rollers receiving a current runs on insulated radial brass strips at the ends of the diameter of the ring at right angles to the connecting line of the electro-magnetic poles, and to these brass strips the wire loops are soldered, which connect two neighbouring portions of the induction bobbin.

Dr. Pacinotti, in a letter to the secretary of the French Academy, dated August 20, 1871 (*Comptes Rendus*), asserts his priority with reference to the transversal electro-magnet rotating between the poles of the electro-magnet, and points to the fact that his machine, made in 1860, is still to be seen in the Cabinet of Technological Physics of the University of Pisa. Pacinotti also exhibited his machine in Vienna in 1873 (see Official General Catalogue), and received the progress medal for it.

In his second communication to the Paris Academy on his machine, on December 2, 1872, Gramme takes no notice of Pacinotti's claim of priority; and this calls forth remonstrance from Pacinotti in *Nuovo Cimento* (Serie II., vol. ix.), in which he also maintains that the name selected by Gramme (in his second paper) for the electro-magnet with ring-formed core, "electro-aimant mobile a poles consequents," is much less suitable than the older name, "elettro-calamita trasversale." Niaudet Breguet speaks only of the "Gramme ring," while Gramme has merely applied the "Siemens dynamo-electric principle" to the "Pacinotti ring." Gramme's merits in the practical working out of the machines in question, and their introduction into technics, physical laboratories, and medicine, remain, naturally, undisputed.

[Dr. Zetzsche next notices some of the recent improvements in Gramme's machine, as described in M. Niaudet Breguet's pamphlet, which we have reviewed at p. 31 of the Electrical News. Omitting some points there sufficiently detailed, we note the following others:—]

In the more recent Gramme machines for electrotyping work, an automatic current breaker (*brise courant*) is introduced, to act in case, through any stoppage of the machine, a secondary current from the bath might reverse the poles of the exciting electro-magnet, of which the consequence would be that the machine, when again put in action, would produce a current with direction contrary to the previous one, and so dissolve again the already precipitated silver, &c. This current breaker is a simple lever with counterpoise which connects the metallic brushes with the electro-magnets so long as the machine works regularly; whereas on diminution of the velocity of the machine and of the attraction by the electro-magnets, the counterpoise moves the current breaker and interrupts that connection.

* Abstract of recent paper by Prof. Zetzsche. Communicated by the Author.

For other purposes, Gramme decomposes the ring-formed electro-magnet into two, by bringing out the connecting wires of the thirty odd numbered bobbins on the right, and those of the thirty even numbered on the left, and arranges brushes for both. By means of a commutator, both these halves of the machine may be arranged along with each other, or one behind the other. This arrangement Gramme employs especially in producing the electric light, so as to be able to obtain the light only at one place, or at two different places, as required.

Such a double ring can be utilised in a peculiar way, if it be made *unsymmetrical*, *i.e.*, if the even bobbins be made with fine fire, and the odd with thick wire. If the current of 2 Bunsen elements be then sent through the thick wire of this ring placed between the poles of a magnet (as shown in a figure), the ring begins to move, and thereby, in the bobbins of fine wire, a current of 16 Bunsen (or about 30 Daniell) elements is induced. Gramme shows, in his third note to the Paris Academy, that this current can be used for telegraphing.

The most recent magneto-induction machine with uninterrupted current of unvaried direction and strength was proposed, in March 1872, by Friedr. v. Hefner Alteneck, director of Siemens and Halske's construction department, and several different sized examples of it were exhibited in Vienna in 1873. Two of the smaller kind were there, in Siemens and Halske's exhibition in the Palace of Industry, and a larger one in the Machinery Hall. Another, connected with an older Siemens machine with I-shaped armature was mounted, for illuminating purposes, on a locomotive, and arranged for field use; the two were connected together so that the current furnished by the smaller magnetised the electro-magnet of the larger. This double machine gave a light intensity equal to 2000 normal candles, and by means of it the central cupola of the Palace of Industry was illuminated. In the Hefner machine, the wire-coils are so arranged that without prejudice to the powerful action of the magnet poles on the windings which serve as induction bobbins, their length, and therewith their internal resistance, is made as small as possible, and (should it prove advantageous) the induction bobbin can be made to rotate alone, while the iron core remains fixed. By this latter method the occurrence of Foucault currents in the interior of an iron armature, of any form, rotating between magnet poles may be avoided. These currents indicate a useless expenditure of work, and add to the heating of the machine. Such heating can be obviated, whereas the heating from currents that are made useful is unavoidable, and at the same time keeps the efficiency of the machine within certain limits. In order to the end stated, the wire is not immediately coiled round the iron core, but on a thin sheet-iron drum or shell enclosing it, but quite separate from it. Each individual winding runs on the curved surface of the drum parallel to its axis, but on the flat surface along a diameter of this surface; thus the windings cross each other groupwise on the flat surface. The whole surface of the drum is thus covered with windings, which are in eight divisions or groups. The whole forms a closed hollow cylinder. The sixteen ends of the eight wire divisions are brought to an eight part disc-shaped commutator, on which, at two opposite points, run two contact rollers, or brushes. The core within the windings is a massive or hollow iron piece, and is supported by two bars which pass through at the two ends of the drum. Outside of the hollow cylinder, lastly, and extending round it laterally about two-thirds, are the external magnet-poles, and they are as near as possible to the cylinder, so that between them and the core there is no greater interval than is necessary to allow the wire coils to pass round freely. Through the peculiar arrangement, in which those sixteen wire ends are connected with the eight sectors of the commutator, which also runs round with the coil, the current, originally changing its direction in the coil divisions after each half passage round of the coil, is transformed to one having always the same direction and conducted away by the rollers or brushes to the external circuit. Apart from the advantage of a fixed core, already noticed, this machine is essentially superior to Pacinotti's in that, as the inoperative portions of windings filling the interior of the Pacinotti ring-shaped core is done away with.

In conclusion, it may, however, be mentioned that in a recent paper to *Nuovo Cimento* (Sept. and Oct., Heft 1874) Pacinotti says the ring in his electro-magnetic machine, if turned backwards, will furnish a current, which strengthens the magnetism of the exciting electro-magnet, and that, therefore, the battery-current may be quite dispensed with: that, further, it is well to make the interior hollow part of the ring as small as possible, but better to leave quite out the inner portions of the coil, and replace the ring with a massive core; only the connexion between the external portions of coil must not thereby be disturbed; so the wire must be wound in a peculiar manner (as in a clew). Pacinotti made a model of such a machine; applied to its commutator, besides the ordinary current collectors, and about 15° from these, another pair of brushes of brass wire, to act as current collectors for the external current, while the current from the former was employed in excitation of the horseshoe electro-magnet. Pacinotti has thus come to the same mode of winding as V. Hefner Alteneck already used in 1872; but of a fixture of the core, he appears not to have thought.

NOTES.

Sir John Hawkshaw, in his Presidential Address to the Members of the British Association, now assembled at Bristol, makes some remarks on the share of Governments in public undertakings, which, though directly referring to the construction and maintenance of railways, apply in their spirit just as well to electric telegraphs. He says:—"And so some countries, Russia for instance, to which improved means of transport are of vital importance, have wisely, in my opinion, caused lines to be made which, having regard to their own expenditure and receipts, would be unprofitable works, but in a national point of view are—or speedily will be—highly advantageous. The Empire of Brazil also, which I have lately visited, is arriving at the conclusion—which I think not an unwise one—that the State can afford and will be benefited in the end by guaranteeing 7 per cent upon any railway that can of itself be shown to produce a net income of 4 per cent, on the assumption that the nation will be benefited at least to the extent of the difference." Now all this, we believe, applies with equal force to telegraphs. Improved means of communication, like improved facilities for transport, increase the wealth of a nation. If, in the carrying them out, some proximate loss is experienced, that loss is only apparent, and may more justly be undertaken by the State than by a number of private individuals. The aims of a national telegraph and of a private or proprietary telegraph are, in one important point, totally distinct. The first seeks to afford the greatest possible convenience to the public, though of course at the least practicable expense; the latter aims simply at making the greatest possible amount of profit by the transmission of messages. These two ends, as every one will see, are not identical, and their diversity may cause very considerable difference in the means em-

ployed. Private enterprise is admirable where it is checked by competition, and where it does not involve the handing over of power to individuals or companies. But where these conditions are reversed—as in case of telegraphs, water and gas supply, &c.—it ought to be superseded by national or municipal action. Were the telegraphs re-committed to private hands, one of the first steps would be the closing of a number of branches occasionally very important to the public, but which, as yet, do not prove remunerative.

Mr. Scudamore has, according to the *Civilian*, commuted his pension for the sum of £11,000. He will, after having enjoyed a little repose on the Continent during the autumn, enter upon his new duties in Constantinople. The vacancy caused by his retirement is not likely to be filled up. A series of papers by Mr. Scudamore, recently contributed to the *Standard* under the *nom de plume* of "The Sleepless Man," will, we understand, be shortly published in a collected form by Messrs. Griffith and Farran.

NOTICES OF BOOKS.

Protection of Life and Property from Lightning during Thunderstorms. By W. McGregor. Bedford: W. J. Robinson. 1875.

Such suggestions as are contained in this pamphlet are much needed, for the cases in which buildings are protected by lightning conductors are rare.

Chapter I. is taken up with an explanation of the different kinds of lightning. Chapter II. dwells upon the "Theory Regarding the Action of Points and Lightning Rods." Chapter III. embraces "Protective Area of Lightning Conductors:" an unsettled and much mooted problem. Chapters IV. and V. "Practical Hints Respecting the Erection of Conductors." Chapters VI. and VII. conclude the pamphlet with general instructions of precautions to be observed, &c., during thunderstorms.

The author is energetic in his advocacy of the use of *sharp points* to the tips of all conductors in preference to blunt ends. The object of the pamphlet being to instruct unscientific readers, this advocacy is good—otherwise the controversy of sharp tips *v.* blunt ends, needed no discussion, the superiority of the former being everywhere acknowledged.

Regarding the limit of protective area, the author has done service in collecting some of the opinions of scientific men on this subject. It is one which deserves special inquiry, as it forms a condition which, unless satisfied, may entirely vitiate the protective effect of a sound lightning rod, so that if either of the two essential conditions (sound structure and good earth connections, and limit of protective area) are not fulfilled simultaneously, the structure is robbed of its capacity for usefulness.

Two rather novel propositions are given. The first is that "fire insurance companies might have greater force than scientific truths in compelling people to adopt precautions to prevent destruction and damage by lightning." The second is a hint how to protect the lives of animals by "attaching rods to tall trees in the neighbourhood of farms; and also to tall flag-staffs, where trees may not be available; such, for instance, as meadows and grazing lands."

We trust that Mr. McGregor will see the principles he has laboured to expound acted upon by the general public.

ELECTRICAL SCIENCE IN FOREIGN JOURNALS.

(This column is devoted to a list of Electrical Memoirs published in Foreign Journals. Those of importance will be either translated in full or given in abstract.)

Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences. Vol. lxxxi., No. 6, August 9, 1875.

On a Peculiarity of a Surface of Electrified Water. —By G. Lippmann.—A mass of water in a glass vase is put to earth through a platinum wire. If a rubbed stick of resin approach the water, positive electricity from the soil is attracted, and distributes itself over the surface of the water. The plantinum wire, serving as an entry-electrode to the positive electricity, bubbles of oxygen gas are disengaged, proportional in quantity to the electricity. Since oxygen has been liberated, hydrogen remains in excess on the surface of the water in some manner *latent* or *bound* during the time the water is electrified; but when the discharge is accomplished, the hydrogen is disengaged. To effect this discharge, it suffices to withdraw the stick of resin. The charge retained by it flows back to earth through the plantinum wire. Indeed, according to Faraday's law, the same quantity of electricity, which, entering the water, disengages *one* equivalent of oxygen, leaving the water, disengages *one* equivalent of hydrogen. We cannot take away any portion of the hidden or latent hydrogen, neither by diffusion, oxidation, nor any physical or chemical action, leaving the electric charge intact. In other terms, the hydrogen is neither combined nor dissolved; and yet it is really there since it is disengaged by removing the stick of resin: here we have, it seems, an example of another order of material combination. The h ydrogen is entirely retained at the *surface* of the water; for we can replace any portion whatever of the interior mass of water by air, and provided we do not change the surface, the electric surface does not change.

Journal Telegraphique. Vol. iii., No. 7, July 25, 1875.

Electric Vote-Registers (Jacquin's System.)—An account of this system will appear in an early number.

Colour-Writing Apparatus for Transmission by the "Repose Current."—G. Hasler.—When we transmit a message with the "working-current," the signs are made upon the paper-band when the armature is attracted towards the magnet. With the "repose current," on the contrary, they are traced when it is separated from the magnet. To transform the ordinary Morse instrument into a "repose-current" one, a second lever with two arms has been frequently used, one of which arms carries the pen, whilst the other is joined, under the form of a hinge, to the lever of the armature. This system, though possessing the advantage of being able to transform the instrument at will from one kind to the other, possesses, however, this inconvenience, that the adjunction of an auxiliary lever weakens the sensibility of the apparatus, and renders its "setting" more difficult. In Bavaria the use of this auxiliary lever has been avoided by adopting the armature to an arm of the writing-lever, which descends perpendicularly, and by submitting it to the action of a magnet placed horizontally.

Construction of Lightning Conductors for Telegraphic Lines.—F. Schaack.

Moniteur Industriel Belge, Nos. 48 and 49, July 10 and 20, 1875.

Pneumatic Relay Telegraphs of Great Lengths.—M. A. Crespin.—See page 110.

Vol. ii., No. 50. August 1, 1875.

Preservation of Timber by Copper Salts.—M. Rottier.—In course of translation.

Bulletin de la Societe d'Encouragement.
No. 18, June 1875.
Contains no papers on electrical subjects.

No. 19, July, 1875.

Electric Apparatus presented by M. Deschiens.—Report by Count du Moncel.—Some of these instruments are divided by M. Liais, Director of the Imperial Observatory of Brazil, viz:—(1.) *An Electro-Chronometric Regulator.* Without attempting a full description we may state that the interruptions of the current are effected under a bell jar filled with hydrogen, and on a mercury surface; thus obviating oxidation of the interrupter. The mechanical action working the interrupter and the pendulum is by a free escapement, which the pendulum only touches at each double oscillation just when passing the vertical. This escapement liberates a lever, solicited by a weight; which lever gives an impulsion to the pendulum, and also, before stopping, acts on a special beam, working the interrupter; the latter then causes an electro-magnet to be excited, which replaces the impelling lever in its former position and restores the escapement. The beam of the interrupter returns of itself to its normal position; so that everything is in position again for the next movement of the pendulum in the same direction. (2.) *An Electro-Chronometric Counter* (indicating on a dial the movements of the regulative pendulum).—To avoid the failure of contacts, M. Liais uses a massive pendulum, of annealed iron, acted on by an electro-magnet, so that if the contact should fail the dial train may not be affected; since the oscillation of the pendulum continuing all the same, the escapement always acts. Further, as the electro-magnetic action is only effective at the extreme points of the oscillations, the numerous contacts sometimes produced, resulting from certain trepidations of the apparatus, have no effect on the counter; as also the irregularities of velocity of the pendulum itself, which cannot quit the extreme point of its oscillation except when the current has ceased to pass through the electro-magnet. (3.) *Electric Chronograph.*—This is an improvement on one made by M. Liais twenty years ago for the Paris Observatory. The registration is not on a paper-covered cylinder, but on a paper sheet fixed on a horizontal circular plate; and the tracings are made in two spiral lines from circumference to centre. Thus a great number of indications can be made on one sheet, and the sheets can be easily kept in a portfolio. The cord of the motor is wound round a fusee, so that the turns of the plate may differ little from each other for the same interval of time. The two tracing styles are kept constantly pointed by the very fact of friction on the paper. The rotation of the plate turns a pulley, covered with a caoutchouc ring, which rests on it; and this turns two other pulleys with which the styles are connected, so that the latter are turned also in a continuous and regular manner. To obtain greater precision, copper points are sometimes used in place of the pencils, and the paper is prepared with zinc-white. (Some other improvements in detail are mentioned.) Among M. Deschien's own instruments is a system of dial telegraph, in which the regulation of the electro-magnetic action is effected in a double manner (by the tension of an antagonistic spring, and by the distance, greater or less, of the armature from the magnetic cores), by means of a double button placed in front of the apparatus, under the dial. This button corresponds to a hollow axis which envelopes a solid axis; the former has a helical groove in which catches a mother screw fitted to the antagonistic spring of the armature; the other, terminated by a screw, and worked exteriorly by means of a key which one introduces into the centre of the button, moves the iron of the electro-magnet, and the plate-form on which it is mounted. This arrangement is very convenient in practice.

No. 20.

List of Prizes Awarded to Various Competitors in Science.

COMMERCIAL NOTES.

The India-Rubber, Gutta-Percha, and Telegraph Works Company have received a telegram from Mr. Gray stating that the Arica Iquique Section of their West Coast of South America cables, about 200 miles long, has been successfully completed. The total length laid on the coast of Peru is now about 860 miles.

The Report of the Submarine Telegraph Company for the half-year ended the 30th June last, which was adopted at the meeting on the 25th inst., states the ordinary receipts at £54,122. This has enabled the directors to declare a dividend at the rate of 15½ per cent, and to add £2251 to reserve, carrying £325 forward. A sum of £12,552, obtained from the Post Office, has been nearly all spent in laying 20 miles of new cable between Boiling Gap and Dieppe.

The estimated traffic receipts of the Anglo-American Telegraph Company for the 18th inst. were £1230; for the 19th, £1330; for the 20th, £1450; for the 21st, £1350; for the 22nd, £260; for the 23rd, £1150.

The thirty-sixth ordinary meeting of the Mediterranean Extension Telegraph Company, Limited, was held on the 25th inst. The Directors' Report, which was carried, stated that the Board have much pleasure in stating that the cables and land-lines of the Company continue in perfect working order, and they were enabled to recommend payment of the half-yearly dividend on the eight per cent preference stock, less income-tax, as usual; and of a dividend at the rate of 3 per cent per annum, free of income-tax, on the ordinary share capital of the Company, payable on and after September 1. There will remain a sum of £500 13s. 4d. to be carried to the reserve fund, which will then stand at £7848 7s. 7d. Mr. H. Moore, the chairman, in moving the usual formal resolution for the adoption of the report, said the receipts were about the same as last half-year, whilst the expenditure was about £100 less, although they had had during that time to supply new instruments.

TELEGRAPH SHARE LIST.

Amount per Share.	Name of Company.	Amount paid up.	Closing Quotations.
£		£	Aug. [illegible]
Stock	Anglo-American	100	[illegible]
10	Black Sea	All	[illegible]
10	Brazilian Submarine	All	[illegible]
10	Cuba	All	[illegible]
10	Ditto, 10 per cent Preference ..	All	[illegible]
10	Direct Spanish	9	[illegible]
10	Ditto, 10 per cent Preference ..	All	[illegible]
20	Direct United States Cable	All	[illegible]
10	Eastern	All	[illegible]
..	Ditto, 6 per cent Debenture	..	[illegible]
10	Ditto, Exten. Australia and China	All	[illegible]
10	German Union Telegraph and Trust	All	[illegible]
10	Globe Telegraph and Trust	All	[illegible]
10	Ditto, 6 per cent Preference	All	[illegible]
10	Great Northern	All	[illegible]
25	Indo-European	All	[illegible]
10	Mediterranean Extension	All	[illegible]
10	Ditto, 8 per cent Preference	All	[illegible]
10	Panama and South Pacific	2½	[illegible]
8	Reuter's	All	[illegible]
Stock	Submarine	100	[illegible]
1	Ditto, Scrip	All	[illegible]
10	West India and Panama	All	[illegible]
10	Ditto, 10 per cent Preference ..	All	[illegible]
20	Western and Brazilian	All	[illegible]
1000 dls.	Western Un. U.S. 7 per cent 1st M.B.	All	[illegible]
100	Ditto, 6 per cent	All	[illegible]
10	Hooper's Telegraph Works	All	[illegible]
50	India-Rubber and Gutta-Percha ..	All	[illegible]
Cert.	Submarine Cables Trust	100	[illegible]
12	Telegraph Construction	All	[illegible]
100	Ditto, 7 per cent Bonds	All	[illegible]

*** Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which "The Electrical News and Telegraphic Reporter" is the organ, will always command attention. Literary communications and books for review should be addressed to the Editor; business communications to the Publisher, Boy Court, Ludgate Hill, London, E.C.

London: Printed and Published by the Proprietor, William Crookes, at the Office, Boy Court, Ludgate Hill, E.C. August 26, 1875.

THE

ELECTRICAL NEWS

AND

Edited by Wm. Crookes, F.R.S., &c.] TELEGRAPHIC REPORTER. [*Registered for Transmission Abroad.*

Vol. 1.—No. 10.] Thursday, September 2, 1875. [PRICE, 4d. POST FREE, 4½d.

CONTENTS.

[TH]E ELECTRICAL NEWS.

Vol. I. No. 10.

BRITISH ASSOCIATION FOR THE [AD]VANCEMENT OF SCIENCE.

Bristol Meeting.

[Sect]ion A.—Mathematical and Physical Science.

[Pres]ident.—Prof. Balfour Stewart, M.A., LL.D., F.R.S. [Vice]-Presidents.—Rev. J. W. Caldicott, D.D.; Prof. [...], F.R.S.; Rev. S. J. Perry, F.R.S.; Prof. Price, [...]; Prof. H. J. S. Smith, F.R.S.; W. Spottiswoode, [...]; Prof. J. J. Sylvester, F.R.S.; Sir W. Thomson, [...]; Prof. Tyndall, F.R.S. [Secr]etaries.—Prof. W. F. Barrett, F.R.S.E., M.R.I.A., [...]; J. W. L. Glaisher, M.A., F.R.S.; C. T. Hudson, LL.D.; G. F. Rodwell, F.R.A.S., F.C.S. [Com]mittee.—Capt. Abney; W. G. Adams, F.R.S.; E. [...]on; Dr. R. S. Ball, F.R.S.; Sir Edward Belcher; [...]W. K. Clifford, F.R.S.; Prof. Clifton, F.R.S.; J. D. [...]tt; Rogers Field; J. A. Fleming; Prof. G. Carey [...], F.R.S.; W. Galloway; Prof. J. H. Gladstone, [...]; James Glaisher, F.R.S.; G. Gore, F.R.S.; F. [...]ie, F.R.S.; Rev. W. Harpley; Prof. Hennessy, [...]; A. S. Herschel; J. Hopkinson, D.Sc.; Dr. J. [...]n; H. M. Jeffery; O. J. Lodge; Rev. R. Main, [...]; J. R. Napier; A. F. Osler; Lord Rayleigh, F.R.S.; A. W. Reinold; Prof. Osborne Reynolds; R. C. [...]; Prof. H. A. Rowland; Prof. Rucker; W. H. L. [...]ll, F.R.S.; Col. Strachey, F.R.S.; Col. Strange, [...]; G. J. Symons; J. Smyth, jun.; T. Sopwith, F.R.S.; [...] Talmage; C. Tomlinson, F.R.S.

[Th]e proceedings of the Section were opened with the [open]ing Address by the President:—

[Sin]ce the last meeting of the British Association science [h]ad to mourn the loss of one of its pioneers, in the [...] of the veteran astronomer Schwabe, of Dessau, at [...]d old age—not before he had faithfully and honour[ably] finished his work. In truth this work was of such a [...]e that the worker could not be expected long to sur[vive] its completion.

[It] is now nearly fifty years since he first began to pro[duce] daily sketches of the spots that appeared upon the [...] surface. Every day on which the sun was visible [...]such days are more frequent in Germany than in this [coun]try), with hardly any intermission for forty years, this [labor]ious and venerable observer made his sketch of the [...] disk. At length this unexampled perseverance met [with] its reward in the discovery of the periodicity of sun[-spot]s, a phenomenon which very speedily attracted the [atten]tion of the scientific world.

[It] is not easy to overrate the importance of the step [gain]ed when a periodicity was found to rule these solar [outb]reaks.

[A] priori, we should not have expected such a pheno[men]on.

[If] the old astronomers were perplexed by the discovery [of s]un-spots, their successors must have been equally [perp]lexed when they ascertained their periodicity. For while [we a]re ready to acknowledge periodicity as one of the natu[ral c]onditions of terrestrial phenomena, yet every one is [incli]ned to ask what there can be to cause it in the be[havi]our of the sun himself? Manifestly it can only have [two] possible causes: it must either be the outcome of [...]s strangely hidden periodical cause residing in the sun [him]self, or must be produced by external bodies, such as [plan]ets, acting somehow in their varied positions on the atmosphere of the sun. But whether the cause be an internal or external one, in either case we are completely ignorant of its nature.

We can easily enough imagine a cause operating from the sun himself and his relations with a surrounding medium to produce great disturbances on his surface, but we cannot easily imagine why disturbances so caused should have a periodicity. On the other hand, we can easily enough attach periodicity to any effect caused by the planets, but we cannot well see why bodies comparatively so insignificant should contribute to such very violent outbreaks as we now know sun-spots to be.

If we look within we are at a loss to account for the periodicity of solar disturbances, and if we look without we are equally at a loss to account for their magnitude. But since that within the sun is hidden from our view, it cannot surely be considered blameworthy if astronomers have directed their attention to that without, and have endeavoured to connect the behaviour of sun-spots with the positions of the various planets.

Stimulated, no doubt, by the success which had attended the labours of Schwabe, an English astronomer was the next to enter the field of solar research.

The aim of Mr. Carrington was, however, rather to obtain very accurate records of the positions, the sizes, and the shapes of the various sun-spots, than to make a very extensive and long-continued series of observations. He was aware that a series at once very accurate and very extended is beyond the power of a private individual, and can only be undertaken by an established institution. Nevertheless each sun-spot that made its appearance during the seven years extending from the beginning of 1854 to the end of 1860 was sketched by Mr. Carrington with the greatest possible accuracy, and had also its heliographic positions—that is to say, its solar latitude and longitude—accurately determined.

One of the most prominent results of Mr. Carrington's labours was the discovery of the fact that sun-spots appear to have a proper motion of their own, those nearer the solar equator moving faster than those more remote. Another was the discovery of changes apparently periodical affecting the disposition of spots in solar latitude. It was already known that sun-spots confined themselves to the sun's equatorial regions, but Mr. Carrington showed that the region affected was liable to periodical elongations and contractions, although his observations were not sufficiently extended to determine the exact length of this period.

Before Mr. Carrington had completed his seven years' labours, celestial photography had been introduced by Mr. Warren De la Rue. Commencing with his private observatory, he next persuaded the Kew Committee of the British Association to allow the systematic photography of the sun to be carried on at their observatory under his superintendence, and in the year 1862 the first of a ten years' series of solar photographs was begun. Before this date, however, Mr. De la Rue had ascertained, by means of his photoheliograph, on the occasion of the total eclipse of 1860, that the red prominences surrounding the eclipsed sun belong, without doubt, to our luminary himself.

The Kew observations are not yet finally reduced, but already several important conclusions have been obtained from them by Mr. De la Rue and the other Kew observers. In the first place the Kew photographs confirm the theory of Wilson that sun-spots are phenomena the dark portions of which exist at a level considerably beneath the general surface of the sun; in other words, they are hollows or pits, the interior of which is, of course, filled up with the solar atmosphere. The Kew observers were likewise led to associate the low temperature of the bottom of sun-spots with the downward carriage of colder matter from the atmosphere of the sun, while the upward rush of heated matter was supposed to account for the faculæ or bright patches which almost invariably accompany spots. In the next place, the Kew observers, making use not only

of the Kew series, but of those of Schwabe and Carrington, which were generously placed at their disposal, have discovered traces of the influence of the nearer planets upon the behaviour of sun-spots. This influence appears to be of such a nature that spots attain their maximum size when carried by rotation into positions as far as possible remote from the influencing planet—that is to say, into positions where the body of the sun is between them and the planet. There is also evidence of an excess of solar action when two influential planets come near together. But although considerable light has thus been thrown on the periodicity of sun-spots, it ought to be borne in mind that the cause of the remarkable period of eleven years and a quarter, originally discovered by Schwabe, has not yet been properly explained. The Kew observers have likewise discovered traces of a peculiar oscillation of spots between the two hemispheres of the sun, and finally their researches will place at the command of the observers the data for ascertaining whether centres of greater and lesser solar activity are connected with certain heliocentric positions.

While the sun's surface was thus being examined both telescopically and photographically, the spectroscope came to be employed as an instrument of research. It had already been surmised by Prof. Stokes that the vapour of sodium at a comparatively low temperature forms one of the constituents of the solar atmosphere, inasmuch as the dark line D in the spectrum of the sun coincides in position with the bright line given out by incandescent sodium vapour.

This method of research was greatly extended by Kirchhoff, who soon found that many of the dark lines in the solar spectrum were coincident with the bright lines of sundry incandescent metallic vapours, and a good beginning was thus made towards ascertaining the chemical constitution of the sun.

The new method soon brought forth further fruit when applied in the hands of Huggins, Miller, Secchi, and others, to the more distant heavenly bodies. It was speedily found that the fixed stars had constitutions very similar to that of the sun. But a peculiar and unexpected success was attained when some of the nebulæ were examined spectroscopically. To-day it seems (so rapidly has knowledge progressed) very much like recalling an old superstition to remind you that, until the advent of the spectroscope, the irresolvable nebulæ were considered to be gigantic and remote clusters of stars, the individual members of which were too distant to be separated from each other, even with a telescope like that of Lord Rosse. But Mr. Huggins, by means of the spectroscope, soon found that this was not the case, and that most of the nebulæ which had defied the telescope gave indications of incandescent hydrogen gas. It was also found by this observer that the proper motions of some of the fixed stars in a direction to or from the earth might be detected by means of the displacement of their spectral lines,—a principle of research which was first enunciated by Fizeau. Hitherto in such applications of the spectroscope the body to be examined was viewed as a whole. It had not yet been attempted to localise the use of this instrument so as to examine particular districts of the sun,—as, for instance, a sun-spot, or the red flames already proved by De la Rue to belong to our luminary. This application was first made by Mr. Lockyer, who, in the year 1865, examined a sun-spot spectroscopically, and remarked the greater thickness of the lines in the spectrum of the darker portion of the spot.

Dr. Frankland had previously found that thick spectral lines correspond to great pressure, and hence the inference from the greater thickness of lines in the umbra of a spot is, that this umbra or dark portion is subject to a greater pressure,—that is to say, it exists below a greater depth of the solar atmosphere than the general surface of the sun. Thus the results derived from the Kew photoheliograph and those derived from the spectroscope were found to confirm each other. Mr. Lockyer next caused a powerful instrument to be constructed for the purpose of viewing spectroscopically the red flames round the sun's border, in the hope that if they consisted of ignited gas the spectroscope would disperse, and thus dilute and destroy the glare which prevents them from being seen on ordinary occasions.

Before this instrument was quite ready, these flames had been analysed spectroscopically by Capt. Herschel, M. Janssen, and others, on the occasion of a total eclipse occurring in India, and they were found to consist of incandescent gas, most probably hydrogen. But the latter of these observers (M. Janssen) made the important observation that the bright lines in the spectrum of these flames remained visible even after the sun had reappeared, from which he argued that a solar eclipse is not necessary for the examination of this region.

Before information of the discovery made by M. Janssen had reached this country, the instrument of Mr. Lockyer had been completed, and he also found that by its means he was able to analyse at leisure the composition of the red flames without the necessity of a total eclipse. An atmosphere of incandescent hydrogen was found to surround our luminary, into which, during the greater solar storms, sundry metallic vapours were injected—sodium, magnesium, and iron forming the three that most frequently made their appearance.

Here we come to an interesting chemical question.

It had been remarked by Maxwell and by Pierce, as the result of the molecular theory of gases, that the final distribution of any number of kinds of gas in a vertical direction under gravity is such that the density of each gas at a given height is the same as if all the other gases had been removed, leaving it alone.

In our own atmosphere the continual disturbances prevent this arrangement from taking place; but in the sun's enormously extended atmosphere (if, indeed, our luminary be not nearly all gaseous) it appears to hold, inasmuch as the upper portion of this atmosphere, dealing with known elements, apparently consists entirely of hydrogen.

Various other vapours are, however, as we have seen, injected from below the photosphere into the solar atmosphere on the occasion of great disturbances; and Mr. Lockyer has asked the question, whether we have not here a true indication of the relative densities of these various vapours derived from the relative heights to which they are injected on such occasions?

This qustion has been asked, but it has not yet received a definite solution; for chemists tell us that the vapour densities of some of the gases injected into the sun's atmosphere on the occasion of disturbances are—as far as they know from terrestrial observations—different from those which would be indicated by taking the relative heights attained in the atmosphere of the sun. Mr. Lockyer has attempted to bring the question a step nearer to its solution by showing that the vapours at the temperature at which their vapour densities have been experimentally determined are not of similar molecular constitution, whereas in the sun we get an indication from the fact that all the elements give us line spectra, that they are in similar molecular states.

Without, however, attempting to settle this question, I may remark that we have here an interesting example of how two branches of science, physics and chemistry, meet together in solar research.

It had already been observed by Kirchhoff that sometimes one or more of the spectral lines of an elementary vapour appear to be reversed in the solar spectrum, while the other lines did not experience reversal. Mr. Lockyer succeeded in obtaining an explanation of this phenomenon. This explanation was found by means of the method of localisation already mentioned.

Hitherto, when taking the spectrum of the electric spark between the two metallic poles of a coil, the arrangements were such as to give an average spectrum of the metal of these poles; but it was found that when the method of localisation was employed, different portions of the spark

gave a different number of lines, the regions near the terminals being rich in lines, while the midway regions give comparatively few.

If we imagine that in the midway regions the metallic vapour given off by the spark is in a rarer state than that near the poles, we are thus led to regard the short lines which cling to the poles as those which require a greater density or nearness of the vapour particles before they make their appearance, while, on the other hand, those which extend all the way between the two poles come to be regarded as those which will continue to make their appearance in vapour of great tenuity.

Now it was remarked that these long lines were the very lines which were reversed in the atmosphere of the sun. Hence when we observe a single coincidence between a dark solar line and the bright line of any metal, we are further led to inquire whether this bright line is one of the long lines which will continue to exist all the way between two terminals of that metal when the spark passes.

If this be the case, then we may argue with much probability that the metal in question really occurs in the solar atmosphere; but if, on the other hand, the coincidence is merely between a solar dark line and a short bright one, then we are led to imagine that it is not a true coincidence, but something which will probably disappear on further examination. This method has already afforded us a means of determining the relative amount of the various metallic vapours in the sun's atmosphere. Thus in some instances all lines are reversed, whereas in others the reversal extends only to a few of the longer lines.

Several new metals have thus been added to the list of those previously detected in the solar atmosphere; and it is now certain that the vapours of hydrogen, potassium, sodium, rubidium, barium, strontium, calcium, magnesium, aluminium, iron, manganese, chromium, cobalt, nickel, titanium, lead, copper, cadmium, zinc, uranium, cerium, vanadium, and palladium occur in our luminary.

I have spoken hitherto only of telescopic spectroscopy; but photography has been found capable of performing the same good service towards the compound instrument consisting of the telescope and its attached spectroscope which it had previously been known to perform towards the telescope alone.

It is of no less importance to secure a permanent record of spectral peculiarities than it is to secure a permanent record of telescopic appearances.

This application of photography to spectrum observations was first commenced on a sufficient scale by Mr. Rutherford, of New York, and already promises to be one of the most valuable aids in solar inquiry.

In connection with the spectroscope I ought here to mention the names of Respighi and Secchi, who have done much in the examination of the solar surface from day to day. It is of great importance to the advancement of our knowledge that two such competent observers are stationed in a country where the climate is so favourable to continued observation.

The examination of the sun's surface by the spectroscope suggests many interesting questions connected with other branches of science. One of these has already been alluded to.

I may mention two others put by Mr. Lockyer, premising, however, that at present we are hardly in a position to reply to them.

It has been asked whether the very high temperatures of the sun and of some of the stars may not be sufficient to produce the disassociation of those molecular structures which cannot be disassociated by any terrestrial means; in other words, the question has been raised whether our so-called elements are really elementary bodies.

A third question is of geological interest. It has been asked whether a study of the solar atmosphere may not throw some light upon the peculiar constitution of the upper strata of the earth's surface, which are known to be of less density than the average interior of our planet.

If we have learned to be independent of total eclipses, as far as the lower portions of the solar atmosphere are concerned, it must be confessed that as yet the upper portions—the outworks of the sun—can only be successfully approached on these rare and precious occasions. Thanks to the various Government expeditions despatched by Great Britain, by the United States, and by several Continental nations,—thanks, also, to the exertions of Lord Lindsay and other astronomers,—we are in the possession of definite information regarding the solar corona.

In the first place, we are now absolutely certain that a large part of this appendage unmistakably belongs to our luminary, and in the next place we know that it consists —in part at least—of an ignited gas giving a peculiar spectrum, which we have not yet been able to identify with that of any known element.

The temptation is great to associate this spectrum with the presence of something lighter than hydrogen, of the nature of which we are yet totally ignorant.

A peculiar physical structure of the corona has likewise been suspected. On the whole, we may say that this is the least known—while it is perhaps the most interesting —region of solar research; most assuredly it is well worthy of further investigation.

If we now turn our attention to matters nearer home, we find that there is a difficulty in grasping the facts of terrestrial meteorology no less formidable than that which assails us when we investigate solar outbreaks. The latter perplex us because the sun is so far away, and because also his conditions are so different from those with which we are here familiar; while, on the other hand, the former perplex us because we are so intimately mixed up with them in our daily lives and actions—because, in fact, the scale is so large and we are so near. The result has been that until quite recently our meteorological operations have been conducted by a band of isolated volunteers, individually capable and skilful, but, from their very isolation, incapable of combining together with advantage to prosecute a scientific campaign. Of late, however, we have begun to perceive that if we are to make any advance in this very interesting and practical subject, a different method must be pursued, and we have already reaped the first fruits of a more enlightened policy; already we have gained some knowledge of the constitution and habits of our atmosphere.

The researches of Wells and Tyndall have thrown much light on the cause of dew. Humboldt, Dove, Buys Ballot, Jelinek, Quetelet, Hansteen, Kupffer, Forbes, Welsh, Glaisher, and others, have done much to give us an accurate knowledge of the distribution of terrestrial temperature.

Great attention has likewise been given to the rainfall of Great Britain and Ireland, chiefly through the exertions of one individual, Mr. G. J. Symons.

To Dove we are indebted for the law of rotation of the wind; to Redfield, for the spiral theory of cyclones; to Francis Galton, for the theory of anti-cyclones; to Buchan, for an investigation into the disposition of atmospheric pressure which precedes peculiar types of weather; to Stevenson, for the conception of barometric gradients; to Scott and Meldrum, for an acquaintance with the disposition of winds which frequently precedes violent outbreaks; and to come to the practical application of laws, we are much indebted to the late Admiral FitzRoy, and the system which he greatly helped to establish, for our telegraphic warnings of coming storms.

Again, the meteorology of the ocean has not been forgotten. The well-known name of Maury will occur to every one as that of a pioneer in this branch of inquiry. FitzRoy, Leverrier, Meldrum, Toynbee, and others, have likewise done much; and it is understood that the meteorological offices of this and other maritime countries are now busily engaged upon this important and practical subject. Finally, the movements of the ocean and the temperatures of the oceanic depths have recently been examined with very great success in vessels despatched

by Her Majesty's Government; and Dr. Carpenter has by this means been able to throw great light upon the convection-currents exhibited by that vast body of water which girdles our globe,

It would be out of place to enter here more minutely into this large subject, and already it may be asked what connection has all this with that part of the address that went before it.

There are, however, strong grounds for supposing that the meteorology of the sun and that of the earth are intimately connected together. Mr. Broun has shown the existence of a meteorological period connected apparently with the sun's rotation, five successive years' observations of the barometer at Singapore all giving the period 25·74 days. Mr. Baxendell, of Manchester, was, I believe, the first to show that the convection-currents of the earth appear to be connected somehow with the state of the sun's surface as regards spots; and still more recently Mr. Meldrum, of the Mauritius Observatory, has shown, by a laborious compilation of ships' logs, and by utilising the meteorological records of the island, that the cyclones in the Indian Ocean are most frequent in years when there are most sun-spots. He likewise affords us grounds for supposing that the rainfall, at least in the tropics, is greatest in years of maximum solar disturbance.

M. Poey has found a similar connection in the case of the West Indian hurricanes; and finally, Piazzi Smyth, Stone, Köppen, and, still more recently, Blanford, have been able to bring to light a cycle of terrestrial temperature having apparent reference to the condition of the sun.

Thus we have strong matter-of-fact grounds for presuming a connection between the meteorology of our luminary and that of our planet, even although we are in complete ignorance as to the exact nature of this bond.

If we now turn to terrestrial magnetism the same connection becomes apparent.

Sir Edward Sabine was the first to show that the disturbances of the magnetism of the earth are most violent during years of maximum sun spots. Mr. Broun has shown that there is likewise a reference in magnetic phenomena to the period of the sun's rotation about his axis, an observation recently confirmed by Hornstein; and still more recently Mr. Broun has shown that the moon has an action upon the earth's magnetism, which is not altogether of a tidal nature, but depends, in part at least, upon the relative position of the sun and moon.

I must trust to your forbearance if I now venture to bring forward considerations of a somewhat speculative nature.

We are all familiar with the generalisation of Hadley; that is to say, we know there are under currents sweeping along the surface of the earth from the poles to the equator, and upper currents sweeping back from the equator to the poles. We are likewise aware that these currents are caused by the unequal temperature of the earth; they are in truth convection currents, and their course is determined by the positions of the hottest and coldest parts of the earth's surface. We may expect them, therefore, to have a reference not so much to the geographical equator and poles as to the hottest and coldest regions. In fact we know that the equatorial regions into which the trade winds rush and from which the anti-trades take their origin, have a certain annual oscillation depending upon the position of the sun, or, in other words, upon the season of the year. We may likewise imagine that the region into which the upper currents pour themselves is not the geographical pole, but the pole of greatest cold.

In the next place we may imagine that these currents, as far as regards a particular place, have a daily oscillation. This has, I believe, been proved as regards the lower currents or trade winds, which are more powerful during the day than during the night, and we may therefore expect it to hold good with regard to the upper currents or anti-trades; in fact we cannot go wrong in supposing that they also, as regards any particular place, exhibit a daily variation in the intensity with which they blow.

Again, we are aware that the earth is a magnet. Let us not now concern ourselves about the origin of its magnetism, but rather let us take it as it is. We must next bear in mind that rarefied air is a good conductor of electricity; indeed, according to recent experiments, an extremely good conductor. The return trades that pass above from the hotter equatorial regions to the poles of cold, consisting of moist rarefied air, are therefore to be regarded in the light of good conductors crossing lines of magnetic force; we may therefore expect them to be the vehicle of electric currents. Such electric currents will of course react on the magnetism of the earth. Now, since the velocity of these upper currents has a daily variation, their influence as exhibited at any place upon the magnetism of the earth may be expected to have a daily variation also.

The question thus arises, Have we possibly here a cause which may account for the well-known daily magnetic variation? Are the peculiarities of this variation such as to correspond to those which might be expected to belong to such electric currents? I think it may be said that, as far as we can judge, there is a likeness of this kind between the peculiarities of these two things; but a more prolonged scrutiny will of course be essential before we can be absolutely certain that such currents are fitted to produce the daily variation of the earth's magnetism.

Besides the daily and yearly periodic changes in these upper convection currents, we should also expect occasional and abrupt changes forming the counterparts of those disturbances in the lower strata with which we are familiar. And these may be expected in like manner to produce non-periodic occasional disturbances of the magnetism of the earth. Now it is well known that such disturbances do occur, and further that they are most frequent in those years when cyclones are most frequent, that is to say, in years of maximum sun-spots. In one word, it appears to be a tenable hypothesis to attribute at least the most prominent magnetic changes to atmospheric motions taking place in the upper regions of the atmosphere where each moving stratum of air becomes a conductor moving across lines of magnetic force; and it was Sir William Thomson, I believe, who first suggested that the motion of conductors across the lines of the earth's magnetic force must be taken into account in any attempted explanation of terrestrial magnetism.

It thus seems possible that the excessive magnetic disturbances which take place in years of maximum sun spots may not be directly caused by any solar action, but may rather be due to the excessive meteorological disturbances which are likewise characteristic of such years; on the other hand, that magnetic and meteorological influence which Mr. Broun has found to be connected with the sun's rotation points to some unknown direct effect produced by our luminary, even if we imagine that the magnetic part of it is caused by the meteorological. Mr. Broun is of opinion that this effect of the sun does not depend upon the amount of spots on his surface.

In the next place, that influence of the sun in virtue of which we have most cyclones and greater meteorological disturbance in the years of maximum spots, cannot, I think (as far as we know at present) be attributed to a change in the heating power of the sun. We have no doubt traces of a temperature effect which appears to depend upon the sun period; but its amount is very small, whereas the variation in cyclonic disturbance is very great. We are thus tempted to associate this cyclone-producing influence of the sun with something different from his light and heat. As far, therefore, as we can judge, our luminary would appear to produce three distinct effects upon our globe. In the first place, a magnetic and meteorological effect, depending somehow

upon his rotation; secondly, a cyclonic effect, depending somehow upon the disturbed state of his surface; and lastly, the well-known light and heat effect with which we are all familiar.

If we now turn to the sun, we find that there are three distinct forms of motion which animate his surface particles. In the first place, each particle is carried round by the rotation of our luminary; secondly, each particle is influenced by the gigantic meteorological disturbances of the surface, in virtue of which it may acquire a velocity ranging as high as 130 or 140 miles a second; and lastly, each particle, on account of its high temperature, is vibrating with extreme rapidity, and the energy of these vibrations communicated to us by means of the etherial medium produces the well-known light and heat effect of the sun.

Now, is it philosophical to suppose that it is only the last of these three motions that influences our earth, while the other two produce absolutely no effect? On the contrary, we are, I think, compelled by considerations connected with the theory of energy, to attribute an influence, whether great or small, to the first two as well as to the last.

We are thus led to suppose that the sun must influence the earth in three ways, one depending on his rotation, another on his meteorological disturbance, and a third by means of the vibrations of his surface particles.

But we have already seen that, as a matter of fact, the sun does appear to influence the earth in three distinct ways—one magnetically and meteorologically, depending apparently on his period of rotation; a second cyclonically, depending apparently on the meteorological conditions of his surface; and a third by means of his light and heat.

Is this merely a coincidence, or has it a meaning of its own? We cannot tell; but I may venture to think that in the pursuit of this problem we ought to be prepared at least to admit the possibility of a threefold influence of the sun.

Even from this very meagre sketch of one of the most interesting and important of physical problems, it cannot fail to appear that while a good deal has already been done, its progress in the future will very greatly depend on the completeness of the method and continuity of the observations by which it is pursued. We have here a field which is of importance not merely to one, or even to two, but almost to every conceivable branch of research.

Why should we not erect in it a sort of science-exchange into which the physicist, the chemist, and the geologist may each carry the fruits of his research, receiving back in return some suggestion, some principle, or some other scientific commodity that will aid him in his own field.

But to establish such a mart must be a national undertaking, and already several nations have acknowledged their obligations in this respect.

Already the German Government have established a Sonnenwarte, the mere building and equipment of which is to cost a large sum. With an appreciation of what the spectroscope has done for this inquiry, the first directorship was offered to Kirchhoff, and on his declining it, Herr Vogel has been placed in charge. In France also a physical observatory is to be erected at Fontenay, on an equal, if not greater scale, of which Janssen has already accepted the directorship; while in Italy there are at least three observatories exclusively devoted to this branch of research.

Nor must we forget that in this country the new observatory at Oxford has been so arranged that it can be employed in such inquiries. But what has England as a nation done?

Some years since, at the Norwich Meeting of this Association, a movement was set on foot by Colonel Strange which resulted in the appointment of a Royal Commission on the advancement of science, with the Duke of Devonshire as chairman. This Commission have quite recently reported on the steps that ought in their opinion to be taken for the advancement of scientific research.

One of their recommendations is expressed in the following words:—

"Important classes of phenomena relating to physical meteorology and to terrestrial and astronomical physics require observations of such a character that they cannot be advantageously carried on otherwise than under the direction of Government. Institutions for the study of such phenomena should be maintained by the Government; and in particular an observatory should be founded specially devoted to astronomical physics."

If the men of science of this country who procured the appointment of this commission, and who subsequently gave evidence before it, will now come forward to support its recommendations, it can hardly be doubted that these will be speedily carried into effect.

But other things besides observations are necessary if we are to pursue with advantage this great physical problem.

One of these is the removal of the intolerable burden that has hitherto been laid upon private meteorologists and magneticians. Expected to furnish their tale of bricks, they have been left to find their own straw. Nothing more wretched can be imagined than the position of an amateur (that is to say, a man who pursues science for the love of it, and is unconnected with any establishment) who has set himself to promote observational inquiries, whether in meteorology or magnetism.

He has first to obtain with great expenditure of time or money, or both, copies of the individual observations taken at some recognised institution. He has next to reduce these in the way that suits his inquiry, an operation again consuming time and demanding means. Let us suppose all this to be successfully accomplished, and a valuable result obtained. It is doubtless embodied in the Transactions of some Society, but it excites little enthusiasm; for it consists of something which cannot be repeated by every one for himself like a new and interesting experiment. Yet the position of such men has recently been improved. Several observatories and other institutions now publish their individual observations; this is done by our Meteorological Office, while Dr. Bergsma, Dr. Neumayer, and Mr. Broun are recent examples of magneticians who have adopted this plan. The publication of the work of the latter is due to the enlightened patronage of the Rajah of Travancore, who has thus placed himself in front of the princes of India and given them an example which it is to be hoped they will follow. But this is only one step in the right direction; another must consist in subsidising private meteorologists and magneticians in order to enable them to obtain the aid of computers in reducing the observations with which they have been furnished. The man of science would thus be able to devote his knowledge, derived from long study, to the methods by which results, and the laws regulating them, are to be obtained; he could be the architect and builder of a scientific structure without being forced to waste his energies on the work of a hodman.

Another hindrance consists in our deficient knowledge as to what observations of value in magnetism and meteorology have already been made. We ought to have an exhaustive catalogue of all that has been done in this respect in our globe, and of the conditions under which the various observations will be accessible to outside inquirers. A catalogue of this kind has been framed by a committee of this Association, but it is confined to the dominions of England, and requires to be supplemented by a list of that which has been done abroad.

A third drawback is the insufficient nature of the present facilities for the invention and improvement of instruments, and for their verification.

We have no doubt advanced greatly in the construction of instruments, especially in those which are self-record-

ing. The names of Brooke, Robinson, Welsh, Osler, and Beckley, will occur to us all as improvers of our instruments of observation. Sir W. Thomson has likewise adapted his electrometer to the wants of meteorology. Dr. Roscoe has given us a self-recording actinometer; but a good instrument for observing the sun's heat is still a desideratum. It ought likewise to be borne in mind that the standard mercurial thermometer is by no means a perfect instrument.

In conclusion, it cannot be doubted that a great generalisation is looming in the distance—a mighty law, we cannot yet tell what, that will reach us, we cannot yet say when. It will involve facts hitherto inexplicable, facts that are scarcely received as such because they appear opposed to our present knowledge of their causes. It is not possible, perhaps, to hasten the arrival of this generalisation beyond a certain point; but we ought not to forget that we *can* hasten it, and that it is our duty to do so. It depends much on ourselves, our resolution, our earnestness, on the scientific policy we adopt, as well as on the power we may have to devote ourselves to special investigations, whether such an advent shall be realised in our day and generation, or whether it shall be indefinitely postponed. If Governments would understand the ultimate *material* advantages of every step forward in science, however inapplicable each may appear for the moment to the wants or pleasures of ordinary life, they would find reasons, patent to the meanest capacities, for bringing the wealth of mind, now lost on the drudgery of common labours, to bear on the search for those wondrous laws which govern every movement, not only of the mighty masses of our system, but of every atom distributed throughout space.

Colonel Strange, in moving a vote of thanks to Prof. Balfour Stewart, felt confident that the subject which their president had brought before them was one of which no one was more entitled to speak. No man at the present time had contributed so much to the knowledge which they possessed of the physical action of the heavenly bodies. He agreed with the President in thinking the Governments of the various countries should give greater facilities to scientific inquiry, and hoped that soon there would be a number of persons acting in different parts of the world under one system by which they could have a daily record of what was taking place.

The vote of thanks was seconded by the Rev. R. Main, and carried with acclamation.

QUADRUPLEX.

By A. EDEN, Assoc. Soc. Tel. Eng.

Duplex working having now become an every-day fact, the attention of electricians in various countries has been directed to the possibility of transmitting two messsages and receiving two messages simultaneously, through one wire, without mutual interference.

Dr. Stark, of Vienna, twenty years ago, suggested a method of accomplishing this, and Dr. Zetzsche states (Electrical News, vol. i., p. 41) that it has been a subject of investigation and experiment in Germany for some time.

This so-called "quadruplex" problem has been solved in various ways, with more or less success, by MM. Meyer and Maron on the Continent, and Dr. Nicholson and Messrs. Prescott and Edison in America.

Mr. Kempe, of Southampton, and Mr. McGauran, of Melbourne, propose systems essentially the same; but while the former has confined himself to theory, the latter has endeavoured to put it into practice, and states that he has not succeeded satisfactorily.

In Dr. Stark's embryo quadruplex—as in Gintl's duplex system—a compensating battery is required, and it is nearly impossible to close this compensating circuit so as to produce perfect signals.

M. Maron's and Dr. Nicholson's systems appear to be similar, each of these gentlemen using one differential relay only, and three current-strengths; M. Maron, however, making use of three permanently magnetised armatures, instead of two as in Dr. Nicholson's invention.

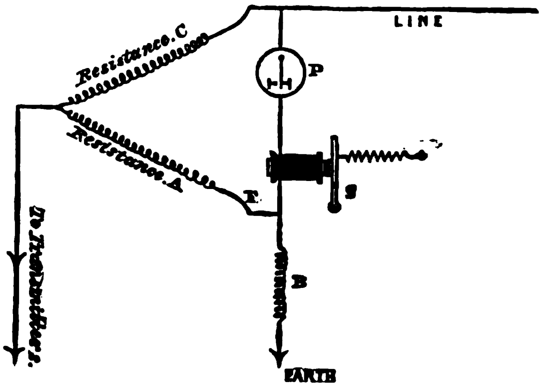
M. Meyer's quadruplex is apparently adapted solely to the transmission of four messages simultaneously in *one* direction; and although it is stated to be in successful operation between Paris and Lyons, the writer is not aware of the existence of any published description.

Messrs. Prescott and Edison and Mr. Kempe avail themselves of the principle of the Wheatstone balance, the former using two and the latter proposing three relays.

Hitherto the most successful quadruplex method appears to be that of Messrs. Prescott and Edison, a description of which was read before the American Electrical Society, by Mr. F. W. Jones.

Briefly described, this "quadruplex" is a Wheatstone balance (Fig. 1) with two relays, s and p, in the position

Fig. 1.



of the galvanometer, and two transmitters at each end of the line. These transmitters would appear to be worked by local batteries brought into action by depressing the sending keys. One of these transmitters being arranged to send (say) a negative current when at rest, and a positive current when its local circuit is closed; the second transmitter putting an extra battery into or out of circuit, without changing the polarity of the existing current, which is solely determined by the position of No. 1 transmitter.

It follows that if A, C, B, and the external R are properly adjusted, the sending station's instruments are unaffected by its own current, but acts on the distant station's polarised relay, P, by the closure of the double current transmitter, and on the distant station's unpolarised relay, S, by the action of the extra-battery transmitter.

If No. 1 transmitter is at rest, and No. 2 closed, S is acted on by a current which keeps P open; but if the armature of No. 1 is also depressed, P closes its local circuit also.

With this arrangement the received current is weakened by a shunt or derivation *via* the "arms" A and C, and it is stated by Mr. Jones that the percentage of effective current is very low.

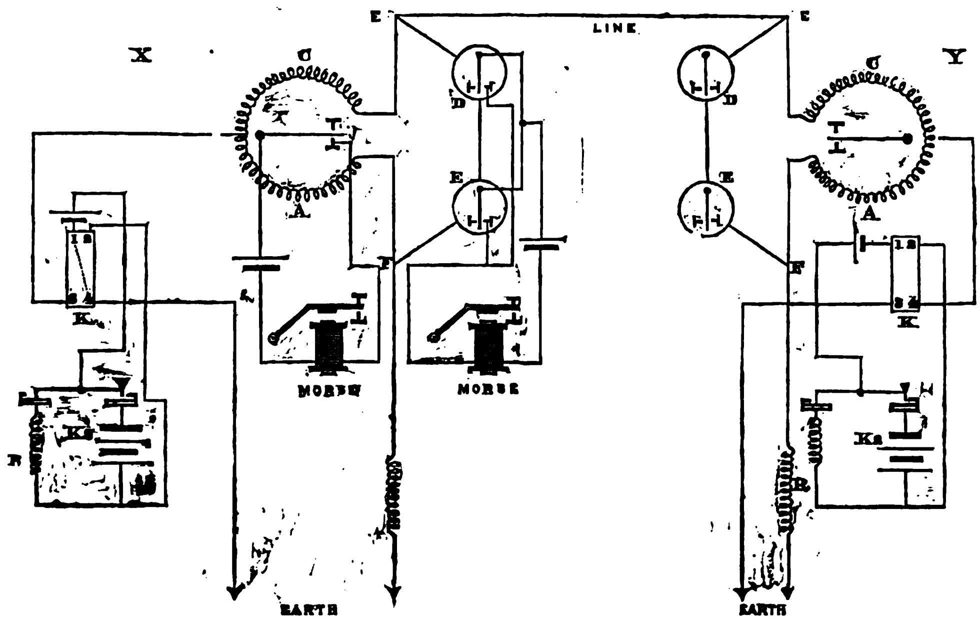
A condenser is attached to the bridge wire (E, F) to prevent the inductive action produced by the current-variations, &c., from interfering with signals.

The writer has given this question some attention at various times, and lately came to the conclusion that a quadruplex which would utilise the current lost *via* the A C shunt would probably be superior to any arrangement hitherto published.

With this view the two following methods were experimented with on a suspended wire of about 100 miles. A and C (Fig. 2) are the two coils of a differentially-wound polarised relay, adjusted for weak currents. D and E are ordinary polarised relays, not sensitively adjusted, forming the bridge-wire of a "Wheatstone balance," A and C being the difficulties consequent on the reversal of the current by K, while K_2 is depressed.

The second method is similar to the first, except that instead of the polarised relays D and E, a soft iron relay is inserted, which is affected by the strong currents from K_2 only.

Fig. 2.



the arms, and B a resistance which (if A and C are equal) is made equal to the external resistance.

K is an ordinary "double current" key so adjusted as to leave the smallest possible interval between the positive and negative currents, during the passage of the lever from the upper to the lower stops, or *vice versâ*. When the key is at rest terminals 1 and 4, 2 and 3 are in connection, but when depressed terminals 1 and 3, 2 and 4 are connected.

K_2 is a single current key with contact springs to prevent the back contact being broken before the front contact is established. This key cuts out of—or puts into—circuit a certain amount of extra force. When at rest K_2 inserts a resistance (R) equal to that of the extra battery with which it is connected. This R is cut out when the key is depressed, and it is intended to prevent any variation in the distant station's balance by the insertion or withdrawal of the extra battery.

The received current passes through C A and D in the same, and through E in the opposite direction. When both keys are at rest a + current is sent from station X (and − from station Y), when K alone is depressed −, when K_2 is pressed down and K at rest 3 +, and when both are depressed 3 −.

A weak negative current closes Y's C A relay, and a weak positive opens it, but neither current has sufficient force to act on D or E. 3 + closes E and keeps C A and D open, while 3 − closes D and C A, but opens E.

Relays D and E are connected with the same Morse as shown in the figure.

This system worked well on the line referred to, although the apparatus was very imperfectly adapted to the end in view.

The relays D and E require weak springs attached to their armatures to prolong the contacts, and thus obviate

A spring is attached to the armature as in the case of D and E in the preceding method, and for the same purpose. The first plan gave more satisfactory results than the second, although this may be owing to the roughly made unpolarised relays with which the writer experimented.

Neither of the methods require a condenser in the bridge wire, and practically the inductive action would appear to be absent.

To avoid complication, the currents from the one station have been referred to as being received at the other, and the theoretical explanations of the duplex signals produced in C A and D E, being generally understood, have not been given, but a mixed differential and "bridge" system seems preferable to a purely differential or purely "bridge" method.

It is evident that a "Wheatstone receiver" differentially wound, could be inserted in A C, and automatic transmission at a high speed adopted.

It may be added that before the springs were attached to the armature, as stated, a secondary battery of lead plates, in connection with the Morse coils, and a shunt so as to afford a passage for the extra current direct, were successively tried in order to keep down the armature of the Morse while the distant station's K was reversing the current, but without any satisfactory result, although the shunt might be adopted with advantage, in addition to the contact springs mentioned.

In our last number we announced that Mr. Scudamore's vacancy as Second Secretary of the Post Office would not be filled up. We have since been informed that Mr. F. E. Baines has been appointed Surveyor-General of Telegraphs, Mr. Patey succeeding Mr. Baines as principal clerk.

ON THE

DECOMPOSITION OF AN ELECTROLYTE BY MAGNETO-ELECTRIC INDUCTION.*

By J. A. FLEMING, B.Sc. (Lond.), F.C.S.,
Cheltenham College.

Many different experimenters, at various times, have brought forward instances in which it was supposed that chemical action could be produced or modified by the aid of static or permanent magnetism. But whatever may be the nature or cause of the effects obtained, we know that the law of conservation of energy will not allow us to believe that any continued chemical action can be effected by the mere presence or neighbourhood of magnets, where at the same time no other expenditure of energy is made. But yet a consideration of this question from a modern standpoint leads me to make the following suggestion:—

When a solid conductor is moved in the field of a magnet, its motion is resisted, if the conductor be forcibly moved against this resistance; the equivalent of the energy so spent reappears in the form of induced currents, and these may be expended partly or wholly in producing heat in the conductor. Supposing, now, that an electrolyte or compound liquid susceptible of decomposition is made to move or flow in a magnetic field, Is it not possible that some small part at least of the work done upon the liquid may be transformed into potential energy of chemical separation? In other words, that the liquid may be to some degree electrolysed by the current produced in it by magneto-electric induction.

Now although the whole of the phenomena of magneto-electric induction, as far as *solid* conductors is concerned, have received a most searching investigation by other physicists as well as by their illustrious discoverer, yet the production of induced currents in liquid conductors seemed worthy of a closer examination, and as I cannot find that anyone has yet attempted to settle the point above referred to, I have endeavoured to reach some conclusion upon it.

Now the inquiry divides itself very naturally into two questions:—

(1.) Does the flow of liquid conductors in a magnetic field, such as the field between the poles of a moderately powerful electro-magnet, give rise to sensible induced currents,—that is to say, can we with ordinary galvanometric means detect them? Theoretically they are possible. It is not the less interesting actually to obtain them.

(2.) Is the production of this induced current in the electrolyte accompanied by its chemical decomposition?

With regard to the first question, it is well-known that Faraday made experiments at Waterloo Bridge, in order to ascertain if the flow of the water of the river Thames across the lines of the earth's magnetic force produced any sensible induced current. But he was not successful. He does not say whether he tried the experiment with a stronger magnetic field and an electrolyte of less resistance.

In the course of his experiments on induction he satisfied himself, however, that liquid conductors could be made to take the place of solid ones, in the phenomena of electro-dynamic induction. He coiled a gutta-percha tube filled with dilute sulphuric acid round the armature of his electro-magnet, and, placing platinum electrodes in the extremities, he found that on making and breaking contact induced currents were produced. Having repeated this, I endeavoured next to obtain the induced current by the movement of the liquid in a constant field, and the following were the experiments made before reaching any positive result:—

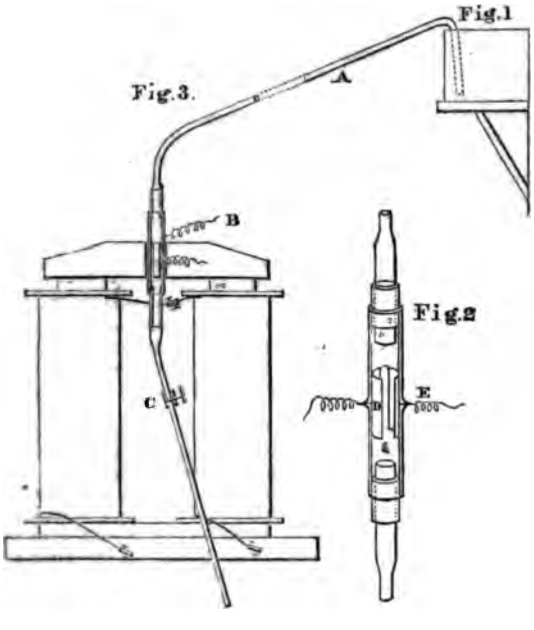
Experiment 1.—On one of the poles of an electro-magnet was placed a deep circular dish, through the centre of the bottom of which a platinum electrode was passed. A similar electrode was placed at the circumference; the dish was then filled with sulphuric acid diluted to its maximum conductivity, sp. gr. 1·23. It was filled so as just to cover the electrodes. A glass paddle was provided to rotate the liquid. The magnet which was used in all the experiments had the following dimensions:—Upright branches, 7·3 c.m. diameter, 41 c.m. long; fixed on a base, 11 c.m. wide, 39 c.m. long; and centres, 25·5 c.m. apart. On these were bobbins of wire 11 c.m. diameter, and 39 c.m. long, and on the ends of the poles could be placed at pleasure pole-pieces or parallelopipeds of soft iron, 7·6 c.m. wide, 5·8 c.m. deep, and 17 c.m. long. The platinum electrodes were connected with a reflecting galvanometer in another room distant about 8 or 10 metres from the magnet. The magnet was excited by 10 or 20 Grove's cells.

The reflecting galvanometer was excessively delicate, the coils being brought very near the needle; this last was about 3 m.m. long, and attached to a small fragment of silvered mirror. The resistance of the coils was about 200 ohms. After having perfectly depolarised the electrodes, and ascertained that when the magnet was not "made" no movement of the liquid produced a current, the magnet was "made," and the liquid rapidly rotated with the paddle. But no indication was given that could with certainty be ascribed to induced currents produced in the liquid, whilst there were many difficulties that rendered accurate observation impossible. The chief one was that the electrodes, being only fixed at one end, were free to vibrate, and the vibration or slight movements caused by the rotation of the liquid gave rise to induced currents in the electrodes, which caused the galvanometer needle to make sudden oscillations from side to side. This experiment, which would, if successful, have been the analogy to that of Faraday, in which a copper plate is made to revolve over a magnetic pole, induced currents being created in a radical direction. It was not pursued any further.

Experiment 2.—After very numerous failures, and trying a large number of different methods for getting a liquid to flow with great yet constant velocity in a magnetic field, the following at last proved perfectly successful:—A glass tube about 200 c.m. long and 2 c.m. in diameter, had platinum plates 65 m.m. long and 15 m.m. wide placed along its inside and at opposite sides with their length parallel to the axis of the tube (see Fig. 2); platinum wires were welded to the centres of these plates, and sealed through the sides of the tubes. Into the ends of this wide tube two tubes of slightly lesser diameter were fixed, and these tubes came down until their ends just projected within the top and bottom edges respectively of the platinum plates. Gutta-percha rings slipped on the ends of these tubes served to press the platinum plates at top and bottom tightly against the sides of the wide tube, and rendered any movement of the plates impossible. This is a very important detail, as will be seen from what follows:—The tube so prepared was fixed in a frame, which held it firmly between the poles of an electro-magnet (see Fig. 3). It was placed so as to be perpendicular to the line joining the poles, and the line joining the centres of the plates was at right angles to the line joining the poles. The pole pieces were placed on the magnet, and the distance between their opposed faces was 25 m.m. To both ends of this tube longer glass tubes were fastened by short gutta-percha tubes; the top was connected with a syphon dipping into a reservoir 2·85 metres above the level of the floor (Fig. 1); the lower tube led down into another reservoir on the floor. The whole of these tubes were made of ordinary glass combustion tube jointed in lengths by gutta-percha connectors, and all bends made of as great curvature as possible to lessen the resistance to the fluid flow. [illegible] cocks above and below the tube containing the platinum plates served to regulate or stop the flow. The magnet was the same used in the former experiments. The

* Read before the British Association, Section A.

battery was 20 Grove's cells, and the current through the magnet was led through a tangent galvanometer in an adjoining room in order to observe the constancy of the current. The liquid used was dilute sulphuric acid, sp. gr. 1·24, temperature 18·2° C., and the resistance per cubic centimetre across opposed faces 1·2926 ohms at 20·8° C. The mirror galvanometer used to detect the induced current was more delicate than that used in experiment 1. It was placed in an adjoining room far beyond the influence of the electro-magnet, insulated wires connected it with the platinum wires, sealed into the tube, and a current reverser, which served also as a contact breaker, and also to throw out of circuit the galvanometer, was interposed. Such being the arrangement, the reservoir was filled with dilute acid, and the syphon also carefully filled, the flow being restrained by a pinch-cock. The apparatus was then left for about forty-eight hours, until all traces of polarisation of the plates had vanished, and not the slightest current was indicated on joining circuit with the galvanoscope. The liquid was then made to flow down, starting it suddenly or gradually, but still not the slightest movement of the galvanoscope needle was seen. The magnet was then "made," using



A. Syphon.
B. Wires to galvanoscope.
C. Clip.
D. Platinum plates.
E. Platinum wires.

20 cells, and now on starting the liquid and joining circuit with the galvanoscope, the needle instantly deflected about 10°. This was frequently repeated, so as to leave no doubt but that this effect was due to the starting of an induced current in the liquid at the moment when it commenced to flow.

But now, although this was repeated very often, I always noticed that the needle would not retain *any constant or permanent deflection whilst the liquid continued flowing with a uniform velocity*.

It is to be noted that since the galvanoscope circuit was not completed until after the magnet was made, this was not due to the mere induced current on making the magnet.

What was observed was this—after the first excursion shown to about 10° or 15°, it oscillated backwards and forwards, but the point of bisection of the limits of its swing continually approached nearer and nearer to the zero of the scale, so that whilst at first this point was 5° to the right, it dropped soon to 3°, 2°, 1°, and after a very short time, although the magnet's field remained constant and the flow uniform, the galvanometer needle was making nearly equal oscillations of diminishing amplitude on either side of zero. On stopping the liquid, the needle gave a very slight but sudden jerk in the opposite direction to that in which it first started. The full meaning of this will be pointed out presently. This experiment, repeated many times without failure when once the difficulties had been overcome, gives us experimental proof that when an electrolyte flows in a magnetic field an induced current is produced in it, and its direction follows the same law as in solids. The line or direction of the current is from one platinum plate to another, and this direction is at right angles to the line of flow or movement; the lines of magnetic force are at right angles to the plane containing the line of flow and line of current.

There are three things on which the success of this experiment depends:—

(1.) The plates must be *perfectly* depolarised to begin with—so perfectly that when contact is made and broken, with the galvanometer timing the breaks so as to fall in with the period of oscillation of the needle, still *no* movement occurs.

(2.) The platinum plates must be so fixed as to be incapable of making the slightest movement under the greatest velocity of liquid used, because otherwise they will, by their movements, produce induced currents.

(3.) The velocity of the liquid should be rendered as uniform as possible, and the strength of the magnet's field also constant.

In the above experiment the velocity of the liquid was 56·9 c.m. per second: this was ascertained by measuring the volume of liquid which flowed through in 35 seconds, and the velocity calculated from the dimensions of the tube.

Having thus obtained practically the induced current in a proving liquid, the next question was attacked, viz., Is the electrolyte to any degree decomposed? To answer this, the platinum plates were again most perfectly depolarised and the galvanoscope disconnected, and the platinum plate short-circuited by joining the wires attached to them. The liquid was then allowed to flow down, the magnet being kept "made," and the circuit was opened *just before* the liquid was stopped. It may here be observed that the liquid was never allowed to run out so far as to empty the syphon, but only drawn off from the reservoir down to a certain limit. The plates were then joined to the galvanoscope, and a slight sudden deflection of the needle of 2° or 3° took place in the *opposite* direction to that in which the induced current would have deflected it under similar circumstances. This proved the polarisation of the electrodes to a certain degree, and this was confirmed by the fact that the deflection of the needle very soon subsided; after a few moments it was again at rest at zero, and no further current could be detected. Now when I first tried this I obtained *no* opposite deflection on joining circuit with the galvanometer, after stopping the flow. I was not altogether satisfied with this result, since sometimes I found no trace of polarisation, and at other times a very slight trace, which did not seem to increase with the length of time during which the acid was allowed to flow down. This was unsatisfactory, but on reflection this appeared to be capable of explanation, thus:—As the liquid flows down in the field an induced current is produced. This current decomposes the liquid, and shows the decomposition by polarising the plates. But the rapid downrush of the liquid *carries away* the film of deposited gases on the plates almost as rapidly as it is formed, and so renders the polarisation not so great as it ought to be. The rate at which the polarisa-

tion is removed will of course depend on the velocity of the liquid.

Now this is confirmed by two facts:—

(1.) If the plates are polarised *artificially*—that is, by another weak current sent for a moment through the liquid —I found I could remove the polarisation much more rapidly by allowing the liquid to rush down strongly for a moment or two than by merely short-circuiting the plates. This proves that the downrush of liquid will remove mechanically the film of gases.

(2.) I was enabled to render the polarisation much greater, and to make it increase—as it should to a certain extent—with the length of time during which the liquid flows, by the following device:—A tube of clean calico or coarse cloth, of the same diameter as the inside of the tube containing the platinum plates, was placed so that the flow of liquid took place down the inside of the cloth tube; the platinum plates were just on the outside of the cloth tube. Now this arrangement offered but little resistance to the induced current, but it perfectly prevented the film of gases or the polarisation from being swept off the tube. The decomposition went on just as before, but the evidence of it was now preserved in the polarisation of the plates.

On repeating the experiment again, as before short-circuiting the plates, allowing the liquid to flow for 30 seconds, opening the circuit, stopping the liquid, and then joining on the galvanoscope, I obtained a deflection of 6° in the opposite direction to that which the induced current itself would have produced.

After 10 seconds short-circuiting it gave only 3°; after 20 seconds no deflection at all. On repeating again, but allowing it to flow for 60 seconds under the same circumstances, a deflection of 10°, due to polarisation, was indicated; after 15 seconds it had fallen to 5°; after 45 seconds none at all.

Now all this proves, I venture to think, that the plates are polarised, and that when joined to a galvanometer they give a current gradually diminishing in strength until it falls to zero, and that the amount of polarisation—as measured by the strength of current produced—*increases* with the time during which the electrolyte is allowed to flow. Here we have the *decomposition of water* produced by allowing it to move in a magnetic field of constant strength, moving so as to cut lines of force at right angles; and this is the only sense in which decomposition by the aid of magnetism could take place. Here we have no violation of the law of conservation, but an interesting example of the transformation of energy. The kinetic energy of the particles of falling water is partly transformed into potential energy of chemical separation in the film of gases deposited on the plates, which, at pleasure, re-appears as the energy of an electric current.

We are now enabled to explain why, in the Experiment 2, on first starting the liquid flow, the deflection of the galvanometer needle was not constant, but returned soon nearly to zero. We see at once that, from the first instant when the flow begins, an opposing electromotive force is brought into play; the current, as it flows, builds up an obstacle against itself in the decomposed electrolyte, and the current due to the flow of liquid in the magnetic field stops as soon as the electromotive force of the polarised plates equals that due to the velocity of the liquid, the strength of the field, and the distance between the plates when this point is reached. *No* further continuous electric current will appear, because the plates are at the same potential. But, practically owing to the cause I have mentioned, some part of the polarisation is continually being removed, and there may be a *very* slight continuous current; but it will not retain its initial value, as is the case with solid conductors. Now, if the electromotive force produced does not exceed or equal that required to decompose freely dilute sulphuric acid—that is about 1·7 volts—no evolution of gas could take place, and at the same time, after the first flow of current, *no* continuous electric current will be produced; in other words, the whole phenomena will resemble that produced when a Daniell's cell is coupled up with a voltameter in circuit. Accordingly, when we state that the electromotive force per unit of length of a conductor moving in a field of magnetic force is equal to the product of strength of field, into velocity of conductor perpendicular to lines of force, or—

$$E = H V,$$

it must be guarded by the statement provided the conductor be not an electrolyte, because if it *is* the equation must take the form—

$$e = H V - e_1,$$

where e is the effective electromotive force urging round the current, and e_1 is a counter electromotive force whose value is a function of the time from the beginning of the current, and which may vary from zero to E, E being the electromotive force which would exist if there were no polarisation.

In conclusion, I should like to point out the bearing of the above facts on Faraday's experiment on the flow of the Thames at Waterloo Bridge. In his experiment he placed plates of copper in the river, connected by a wire 960 feet long; and from the context I gather that he anticipated obtaining a continuous electric current, due to the flow of the Thames in a direction nearly at right angles to the magnetic meridian. And since the "dip" is a large angle, in this case we might have expected to find a current traversing the Thames from side to side. Now, in the absence of any information as to the size of the plates used by Faraday, the velocity of the river, the resistance of the water, and the resistance of the galvanometer, we cannot calculate what the strength of the current or the electromotive force really is. But the electromotive force is certainly a small fraction of that of a Daniell's cell, and accordingly, by what has been shown above, even if Faraday's galvanometer could have detected a current of the strength which would be produced, yet, owing to this polarisation of the plates,—even if all other canses of error had been overcome,—would effectually have prevented anything more than a transient current at first immersion; and this would not have been detected unless the plates had previously been most carefully depolarised.

Perhaps I may, however, venture to suggest a way in which it would probably be possible to obtain evidence of the induced currents produced in rivers flowing across the earth's lines of force. If two non-polarisable electrodes, *e.g.*, plates of copper in porous vessels of sulphate of copper, were attached to a very delicate reflecting galvanometer, and then placed in the Thames, first both at one side close together connected with the galvanometer, and left until every trace of permanent current had subsided. If then the circuit be opened and *one* electrode transferred to the opposite side of the river without removing it from the water, we ought to find on making contact a permanent current due to the magneto-electric induction. Polarisation would be abolished, and any current discovered should be due to the magneto-electric induction alone. Into the further question, however, of the magneto-electric phenomena accompanying the flow of ocean currents and rivers, it is not possible here to enter. It is a question of the greatest interest, and one which will amply repay the attention of physicists.

Prof. H. A. Rowland (Baltimore) had listened with great interest to Mr. Fleming's paper, but at the same ttme he had great doubt as to the liquid being decomposed in this case. When an electromotive force of such small amount acts upon a liquid, there was no doubt about the current passing, but whether the liquid is decomposed or not was another question. According to the principle of the conservation of energy we can calculate the electromotive force required to decompose water, and t is far greater than that of this experiment. Helmholtz

explanation seemed to him to be the proper one, and we must look to the air dissolved in the liquid for the reason of this apparent departure from the law of the conservation of energy.

Mr. Fleming replied as follows:—With all deference to Prof. Rowland's remarks, I cannot yet quite agree with his conclusions. In his treatise on electricity, Prof. Clerk Maxwell states that polarisation is in every case to be held as evidence of chemical decomposition. There is no violation of the law of conservation of energy, and the mere presence of air dissolved in the liquid could never—without *accompanying* chemical decomposition—give rise to the counter electro-motive force of polarisation, which experiment shows to exist.

ON PHENOMENA PRODUCED BY HIGH POTENTIAL ELECTRIC CURRENTS, AND THEIR ANALOGIES WITH NATURAL PHENOMENA.

By GASTON PLANTÉ.

This question was a short time ago ventilated in a paper I had the honour to lay before the Academy of Sciences.* Since then the following facts have been brought to notice, which I deem of interest as bearing upon the same subject.

By using a U-shaped voltameter full of salt water, and submitting it to the action of an electric source such as was used before, it was observed that—If, when the negative wire is plunged into one of the tube-voltameter's branches, the extremity of the positive wire—slightly bent back—be brought into contact with the glass of the other branch, a little above the liquid, a sparkling crown, or wreath, produced by the saline particles which cover the tube, will be at first perceived. On causing the wire to approach the liquid a depression is produced; a luminous arc, bounded by radiating striæ, appears along the glass, and becomes transformed into a demi-wreath of sinuous outline, animated by a rapid undulatory movement. A peculiar, incessantly increasing, rustling noise is heard, and some steam escapes in rapid jets, as if it came from a boiler under pressure. In a short time, the liquid which moistened the glass around the electrode having evaporated, these effects cease; only, however, to recommence immediately afterwards. If the wire be immersed yet deeper, a closed luminous ring is formed; to this ring another succeeds, and we have thus a generation of brilliant waves, in the middle of which the liquid is agitated by a rapid whirling movement. Sometimes around the eddying liquids small luminous irregular rings are seen detached from the glass and the electrode; then all these waves terminate by mutually mingling together, the liquid becomes completely luminous, and partakes of a violent ebullition. During this time the deflection of a magnetised needle placed near the circuit betokens continual variations.

The following experiment illustrates a curious effect arising from the vaporisation of water by electricity:—If the positive platinum wire be introduced into an open capillary tube, so that the wire reaches the level of the lower orifice of the tube, a rustling noise is produced on plunging it in; and if it be lifted up again, a sudden slight detonation is heard, similar to that from a percussion-cap. The tube is not, for all that, either broken or split; but the lower capillary orifice, where the end of the platinum wire is, is rendered conical in form, and the glass is hollowed into a funnel shape. Nevertheless there has not been a discharge (properly so called), for the electrode produces no noisy spark, either on entering or leaving the liquid; the phenomenon is purely mechanical, due to the sudden entry of the air into the tube. The intensity of the noise is remarkable when we consider the scantiness of the annular space between the wire and the tube, and that the tube is open at both ends. We have, however, common examples—such as a thunder-clap, noises caused by the energetic displacement of free air; and it may be conjectured that wherever an empty space is made by so rapid a motion as that of electricity, this sort of *electric clap* will be produced. If the capillary tube be closed at top, the phenomenon is reproduced with great facility.

When the platinum wire is restored to the open tube the vapour bubbles formed at its extremity break the current: as they condense the liquid is drawn up into the tube to re-fill the empty space thus formed, and rises to the upper portion, whence it falls back again in sparkling filets. Fresh balls of vapour re-form and condense, the liquid remounts, and the phenomenon reproduces itself in an intermittent manner.

In the previous experiments the positive wire was in contact with the U tube: if this wire be plunged into the liquid without touching the glass, luminous globules (already described*) animated by a gyratory movement will be produced. The length of the liquid column is not an obstacle to their production; it appears to behave as the insulating plate of a condenser. When the negative wire is deeply immersed, and the liquid around it thus kept strongly negative, the luminous globules formed at the positive pole disappear without sparks at the negative pole, and allow the electricity they enclose to flow into the air or to the surface of the liquid. But, when the negative wire is only slightly immersed, if the positive wire be also immersed its immersed surface is soon found to be greater than that of the negative wire, by the spherical agglomeration of the liquid in its neighbourhood. The current then traverses the voltameter, instead of remaining accumulated at the surface, and the properly called discharge is then produced with a noisy spark, fusion, or volatilisation, of the electrode at the negative pole.

Several conclusions may be drawn from these phenomena, in explanation of the effects of atmospheric electricity.

First of all we meet with representation of various kinds of lightning flashes. The electrified globules formed by the aqueous vesicles of the clouds may be produced or dissipated without explosion, and so give rise to electric glimmerings (or flashes without thunder, as are sometimes seen in the middle of storm-clouds). We can also understand how electrified globes, observed near the ground, may be harmless under certain circumstances, may pass near observers without striking them, may locate themselves on telegraph wires without melting or volatilising them. The phenomenon just described under the name of electric thunder-clap may illustrate the noise of thunder,—not that there is in this case a discharge as at the time of the thunder-stroke; but this experiment offers an analysis of the noise which is produced at the time of the cessation of all electrical effect powerful enough to have previously vaporised or volatilised the material opposed to its passage.

The same series of experiments explains the crackling noise of waterspouts; the mist which is formed around them, likened to that which leaves a steam-boiler; the silent flashes which rend them; the fire-balls at their extremity; and the bubbling agitation of the waters when they touch the surface of the sea. These meteors may be compared to positive liquid or vapour electrodes from which the powerful electric currents of storm-clouds escape towards the land or sea; and, if they are not accompanied with fulminating effects, it is because the conducting cloud accompanies them to the earth, and because there is not in that case a properly called electric discharge, any more than in our experiments. The conical form of waterspouts may be explained by the tendency of positive electricity to fashion itself to a point under certain conditions. As to their gyratory motion, though the electric flow seems to produce by itself whirling effects, mechanical actions may also account for them, and we can only affirm

* See Electrical News, vol. i., p. 7.

* Electrical News, p. 7.

that electricity is the cause or effect of it. Electricity plays a most important part in these meteors, and if the descending movement appears to be the natural motion of waterspouts, the suction effects repeatedly observed when the cloud-cone reaches the surface of the ground or sea may be explained by the vaporisation which the escaping electric torrent produces, by the empty space resulting from it, and the tendency of all matter to be precipitated there.

We also recognise in these experiments the principal phenomena of *polar auroras*—such as luminous arcs; the crowns and demi-crowns of brilliant rays, or of sinuous outlines animated by an undulatory movement; the crackling noise attending them; that luminous effervescence which has been compared to a sea of flames; the condensation of vapours; and the magnetic storms accompanying these grand natural phenomena. The concaveness of the luminous arc in the voltameter, turned towards the point whence the positive electricity flows when compared with aurora arcs turned towards the earth, shows that the flow of electric currents brought from the Equator by the upper winds takes place from the regions of high atmospheres to those still more elevated. These currents—by clashing against the polar frozen clouds, which correspond to the saline particles and the damp glass of the voltameter—become transformed into heat and light, and vaporise the polar clouds, which fall down condensed as abundant snows or rains.* Thus the polar auroras are not due to discharges between the electricity of the air and of the ground, but rather to dissemination into the high air—under a calorific and luminous form—of large masses of electricity proceeding from the surface of the terrestrial globe.

Lastly, if we may still further extend these analogies, we meet in the foregoing phenomena (such as these electrical globules endowed with a gyratory motion, or whirlwinds detached from electrified matter, luminous at their periphery) with an infinitely small reproduction of the possible manner of formation of celestial bodies,—spherical or annular,—and a rapid representation of their development until their extinction or transformation into space. One is thus led to believe that—in the consideration of the first impulse given to the work of creation, or the number of different movements impressed upon ethereal matter in this work—we ought to take into account this particular mode of movement which constitutes electricity, although it be masked under the more striking appearances of heat and light.

NOTES.

The meeting of the British Association for 1876 will be held at Glasgow, and will commence on September 6. Sir Robert Christison, Edinburgh, has been nominated president elect, and the vice-presidents chosen are the Duke of Argyll, Sir William Stirling-Maxwell, Sir William Thomson, the Lord Provost of Glasgow, Dr. Allan Thomson, and Professor A. C. Ramsay. The meeting for 1877 will be held at Plymouth.

During the meeting of the Association at Bristol there were two *soirées* in the Colston Hall. The first was under the auspices of the Bristol and Bath Microscopical Societies. At the second several electrical inventions were exhibited. The display of telegraphic apparatus, which, to a certain extent, was an historical one, contained the original instrument of Wheatstone and Cooke, which was used on the first telegraphic circuit, viz., that between Paddington and Slough.

* The appearance of aurora borealis is almost always accompanied by great downfalls of rains or snows.

ELECTRICAL SCIENCE IN FOREIGN JOURNALS.

(This column is devoted to a list of Electrical Memoirs published in Foreign Journals. Those of importance will be either translated in full or given in abstract.)

Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences. Vol. lxxxi., No. 7, August 16, 1875.

On the Electric Conductivity of Indifferently-Conducting Bodies. Electric Polarisation of Metals.—By the Count Th. du Moncel.—An abstract will appear in our next number.

On Processes of Magnetisation.—J. M. Gaugain.—The author, who says the process of magnetisation usually called "double touch" may be analysed in the same manner as that of "single touch," proceeds to analyse it on theoretical grounds.

Dingler's Polytechnisches Journal, Second July Number.

Construction of Lightning-Conductors for Electric Telegraphs.—M. Schaack.—(See p. 112.)

Electric Voting Apparatus.—An account of this apparatus has already appeared. (See page 13.)

Annales Telegraphiques. Third Series, Vol. ii., July and August, 1875.

General Application of T-Iron in the Construction of Telegraph Lines.—By De la Taille, Inspector of Telegraph Lines.

Respecting Horn-Ashes for Batteries.—H, Sauvage.—In course of translation.

Lenoir's Autographic Apparatus.—Abstracts of this and the two following papers will appear in an early number.

A New System of Vision Telegraph.—A. Léard.

Metallic Thermoscope for the Control of Night Signals.—E. Hardy.

Note on Brooks's Insulators.—M. Gaugain.

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Edited by okes, F.R.S., &c.] **TELEGRAPHIC REPORTER.** [Registered for Transmission Abroad.

1.—No. 11.] Thursday, September 9, 1875. [Price, 4d. Post Free, 4½d.

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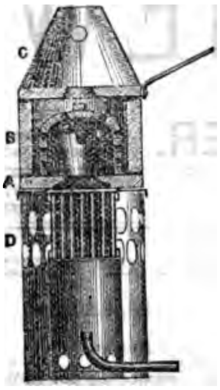

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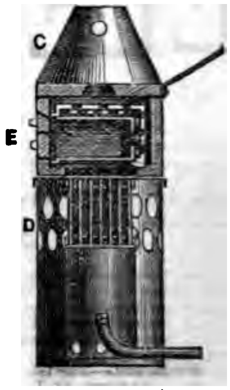

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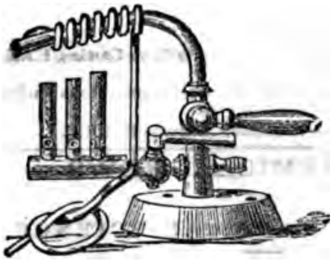

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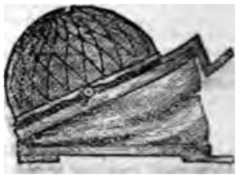

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)DITIONAL NOTES ON QUADRUPLEX.

By A. EDEN.

writing the paper on Quadruplex, which appeared : ELECTRICAL NEWS of the 2nd inst., a series of ments—based on considerations connected with the f current through the "Bridge" wire—have shown ıe most advantageous arrangement is made by in- g one coil of the differential receiving instrument en the point F (Fig. 2, page 123) and the adjusting ınce—forming the arm C with the other coil of the ment as in the figure—and, instead of the instru- coil marked A, a resistance equal to the instrument : is inserted; that is to say one arm of the bridge leading to the line) is formed by the half coil of the ıntial instrument; the other arm of the bridge con- of a resistance equal to this coil; the remaining ment coil forms part of the balancing resistance.

unpolarised relay placed in the Bridge wire worked no condenser being required.

: keys were joined up as shown in Fig. 2, the battery ıed to K having 40, and that connected to K_2 80 although no inconvenience resulted when K was 30 and K_2 120 cells.*

e line experimented on was 98 miles in length, of ı about 4 was underground and the remaining 94 suspended wire.

the close of the last experiment the mileage ation was 1,274,000, and the conductivity mileage ohms.

reference to Professor Zetzsche's remark† regarding ifficulties consequent on the reversal of the current : the unpolarised relay is depressed, I may add that der to prevent the "split" which is likely to be pro- d in the Morse signals by this reversal, the local ry connections can be arranged so that the circuit is nually closed through the Morse coil; but when the ture of the unpolarised relay is in the position of a shunt is inserted which weakens the current through Aorse so as to release its armature. When the relay ıture is depressed in the slightest degree the shunt is ı out of circuit and the Morse acted on.

ıis method, although working the local battery er, makes it possible for the relay armature to be :d slightly from the "bottom-stop" (on which there o connection) without interfering with the Morse als.

is also much more reliable than any spring arrange- t, and has reference solely to the interruption caused ıe movement of K while K_2 is depressed.

o interference is produced in the signals received on polarised relay by the movement of K_2.

ON

TERMINATION OF FAULTS IN SUBMARINE CABLES.

a recent paper to the Berlin Academy, Dr. Werner mens discusses various points connected with the sub- ging of cables. The following is an abstract of what says with reference to testing for faults :—

The theoretical basis for such determination of faults I e in 1850. From two measurements of current or istance two equations are obtained, with aid of which we can eliminate the unknown resistance of the fault, *i.e.*, the resistance opposed, at the place of the fault, to the passage of electricity to earth, and then ascertain the distance of the fault from the end of the line. The current measurement may either be made simultaneously from both sides of the insulated conductor, in which case the distant end can be insulated or connected to earth; or both may be made from one side, the distant end being, for one measurement insulated, for the other connected to earth. As measurements of resistance are more accurate and easy to carry out, I afterwards changed the formulæ for place of fault based on current measurements, to equivalent ones based on resistance measurements, having first fixed a unit and scale of resistance. Owing, however, to the variability of physical properties of the place of fault, determinations based on the formulæ obtained are but seldom practicable in cable laying, and only so where the fault is a considerable one, *i.e.*, has little resistance.

Recently, Messrs. Clark and Jenkin have made known two methods for determining the place of a fault which mostly remedy the evils of my previous method. Mr. Clark insulates one end of the line, and inserts between the other end and the earth a galvanic battery and a known resistance. With the help of accurately agreeing electrometers, the difference of potential of the battery pole connected with the resistance, and of the cable end, are measured; also the potential of the other insulated end of the line. This latter gives the potential at the place of the fault in the line; then, if w represent the inserted resistance, P and P' the measured potentials of its ends, p the measured potential at the other end of the line,—

$$P - P' : w = P' - p : x;$$

x denoting the resistance of the line from the station where the battery is inserted to the fault. Hence—

$$x = \frac{w(P' - p)}{P - P'}.$$

Provided the measurements of P, P', and p are simultaneous, and made either in absolute measure or with accurately agreeing instruments, the variability of resistance of the place of fault is without influence on the result. The injurious influence of polarisation of the place of fault is also really eliminated. The difficulties, however, of the three simultaneous measurements at different places are very great, and it is also difficult to reach the necessary accuracy in electrometer measurements.

Mr. Jenkin's method consists in measuring simultaneously the current going through the fault and the potential of both ends of the line. For this purpose a battery with galvanometer is introduced between one end of the line and the earth, while the other end of the line is insulated. Both ends are connected with electrometers. In Mr. Jenkin's formula—

$$x = \frac{1}{2\sqrt{\frac{k}{i}}} \ln \frac{P + \frac{k}{\sqrt{\frac{k}{2}}} J - P' e^{l}\sqrt{\frac{k}{i}}}{-P + \frac{k}{\sqrt{\frac{k}{i}}} J + P' e^{-l}\sqrt{\frac{k}{i}}}$$

in which x is the distance sought, k the resistance of unit length of the line, J the current through the galvanometer, in absolute measure, and P and P' the potentials at beginning and end of the line, in absolute measure; the loss of current through the insulating sheath of the conductor is taken into account. As, in the case of small cable faults (determination of which is always the most difficult), the imperfect insulation is an essential element, Jenkin's formula would be of great value if the *simultaneous* measurement of a current strength and two potentials, in absolute measure, in different places, and

* Daniell's internal resistance 10 ohms per cell.
† ELECTRICAL NEWS, vol. i., No. 4, p. 42.

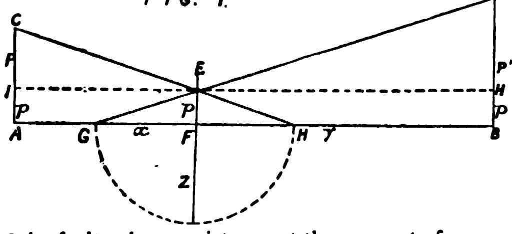
with the necessary accuracy, did not render it less available in practical work.

From what has been said, it will be seen that a method of determining faults can be reliable only if the very inconstant resistance and the variable polarisation of the place of fault be rendered unprejudicial by it. For faults with great resistance, there is added the condition that the insulation current, *i.e.*, the current passing through the mass of the insulator throughout the entire length of the faultless cable, be taken into account or eliminated. The method must, further, be quickly and easily carried out.

I believe these conditions to be in some measure fulfilled by the following method:—

Let A B (Fig. 1) denote the faulty cable; F, the position

FIG. 1.

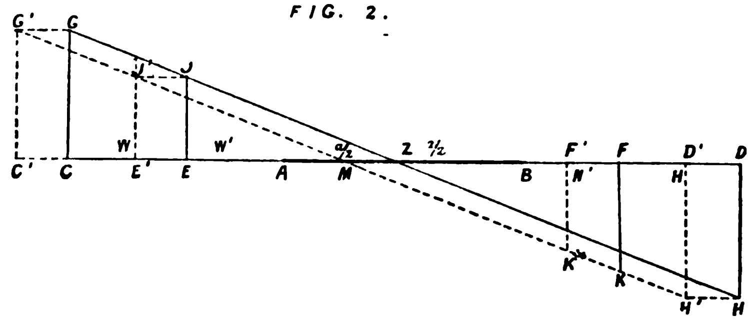


of the fault, whose resistance at the moment of measurement $= x =$ F G = F H. Let A C = P be the measure of potential which a galvanic battery introduced between A and the earth produces in the cable end. Then C H represents the fall of the current going through the fault, and E F the potential in F, if the other end of the line at B is insulated. At B also there will be the potential p, if, as we may suppose for the present, the cable sheath, as far as the fault F, is perfectly insulating. If we now draw a straight minate electromotive force. [Dr. Siemens gives some further details on this point.] The measurements in determination of the fault can be simply effected thus:— Station A inserts a battery between cable end and earth; the charge and polarisation of the place of fault having become constant, A and B read off the deflection of their galvanometers, and A then breaks the contact of the cable end with the free battery pole; B perceives this by the diminished deflection of his galvanometer. He communicates to A, by conventional current, the amount of deflection obtained, and then brings the like free pole of his battery in contact with his cable end. Station A then gives information by an agreed signal, whether his galvanometer has been more or less deflected than B's was. B now increases or diminishes the electromotive force of his battery, till he receives a signal from A that equality of deflection has been reached. For control, A and B then alternately connect their batteries with the cable end, and correct the electromotive force until each produces the same deflection at the other end of the line.

Instead of the foregoing method of removing the influence of variability of physical properties at the place of fault, by making the determinant measurements at both ends of the line as simultaneously as possible, so that the fault for both may be regarded as constant, the same end may be attained by making the electric potential of the place of fault = o.

If we connect with one end of an insulated cylindrical conductor the positive pole, and to the other the negative pole, of an earth-connected galvanic circuit, the curve of tension cuts the cable in the middle, if the conductor is insulated and homogeneous, and the batteries have equal electromotive force. By insertion and removal of resistances between the batteries and the corresponding cable ends, we may displace this tensionless point in the cable at will. If it is so displaced that it coincides with the

FIG. 2.



line through G and E, D B is the measure of a potential P', which if, conversely, the cable is insulated at A, communicates the same potential p to the place of fault F, which it formerly received through P from A. Now the triangles C I E and D H E are similar; hence—

$$P - p : P' - p = x : y,$$

where x and y denote the distance of the fault from the two ends A and B of the line. Since $x + y$ is the known length of the line, the position of the fault is thus exactly determined. Supposing the resistance and polarisation are the same in both measurements, which are close one upon the other, they are without influence on the result of the measurement. Likewise the imperfect insulation by the sheath of the conductor is, in that case, without influence on the result of measurement, if the fault lies at the middle of the line, or near it. If, on the other hand, it is near one end, a correction can easily be made, which compensates the influence sufficiently. The measurements of potential can be effected with sufficient accuracy, if each station be furnished with a sensitive mirror galvanometer (to which any degree of sensibility can be given by a regulable branch circuit), a very great resistance (some millions of *units*), and the means of constructing a battery of deter-

place of fault, no current goes through the fault; which is thus without influence on the current strength of the cable ends and the form of the curve of tension.

In the annexed scheme of tension (Fig. 2) let A B represent the cable, C E and D F equal resistances, E A and B F equal but variable resistances, and, further, G J Z K H the line of tension of the faultless cable, the difference of potential G C − J E will be increased, and, on the other hand, the difference of tension D H − F K will be diminished, if a fault occur at M. If, now, station A increases his variable resistance, E A and station B, at the same time, diminishes his variable resistance B F, till at both stations the formerly measured difference of potential—

G C − J E = D H − F K

is restored. The dotted line G' M H' is now the line of tension, and the resistance inserted at A, removed at B, is the measure of the displacement of the tensionless point in the cable, as also the measure of the distance of the fault from the middle. If the measurement is correctly done, the resistance removed at the one station must be equal to that inserted at the other. The difference of potential, C G − E J or D H − F K, can, as in the former case, be measured by discharge of a condenser, the coatings of which are connected with C and E (or

B and F), or by deflection of a sensitive galvanometer, the wire ends of which are connected through very great resistances with C and F (or D and F).

[Dr. Siemens proceeds to consider the case of a sundering of the cable, either in its metallic core alone, or throughout the section, and suggests improved methods of determining the place of fracture. For particulars of these, however, the reader is referred to Dr. Siemens's paper, which will be found in *Poggendorff's Annalen*, No. 6, 1875.]

ON ELECTRICAL APPARATUS USED IN MODERN BLASTING OPERATIONS.

The applications of electricity in mining operations have greatly developed of late years; and the older methods of blasting are being extensively replaced by others that are swifter, more certain, and more economical in their results. An instructive paper on the subject, in the *Annales de Chimie et de Physique*, by MM. Champion, Pellet, and Grenier, describes some of the principal recent improvements in this direction. We here give an abstract of the portion relating to apparatus used in generating electricity for the purpose in question.

Of *induction apparatus*, the Ruhmkorff coil, though powerful, must almost be relegated to the class of laboratory instruments, owing to the delicacy of the batteries required for it, and the trouble of their maintenance. In certain cases, however, it may with skill be used successfully in blasting. M. Gaiffe has constructed for medical uses, a very compact form of the Ruhmkorff coil, excited by elements of chloride of silver of remarkable constancy. This can be used for induction fuses; but it is not altogether free from the disadvantages of the Ruhmkorff coil.

In Markus's apparatus (which is an ingenious modification of Clarke's) a piece of soft iron, moved by a spring, turns rapidly before induction bobbins placed on a magnet, and furnishes a series of currents, whose succession, as rapid as the movement of the armature, produces a current that may be considered continuous. It is useful for simultaneous explosion of a large number of fuses, and is generally employed in Germany. Wheatstone's apparatus, used in England, is based on the same principle.

The Gramme and Alliance machines, owing to their volume and high price, can be used only in particular cases.

The instrument known as *Coup de poing Breguet* consists of a piece of soft iron which one separates suddenly, by a blow of the hand, from the armature of a magnet which carries two induction coils. By a particular arrangement the intensity of the current is considerably increased by means of the extra current. M. Breguet has lately utilised in his apparatus the laminated magnets of M. Jamin, the united plates of which give a much greater intensity, for the same volume, than ordinary magnets. The magnet and bobbins must be enveloped in a caoutchouc bag, or covered with thick insulating varnish, on account of atmospheric moisture.

The theory of the Breguet exploder is briefly this:—At the moment of detaching, a first instantaneous induction current is produced in the wire. When the piece of soft iron (*i.e.* armature) is in contact with the polar surfaces of the magnet, the poles of the latter are at some distance from the armature; when the armature is removed, the poles shift towards the extremities of the magnet. It is just as if the magnet were moved parallel to itself in the interior of the bobbins. The current is produced, as in Faraday's experiment, by influence of a magnet suddenly introduced into a bobbin. So long as the armature is withheld, the apparatus is inert. On ceasing to press back the armature, it returns quickly to contact with the poles, and a second current is produced in the wire of contrary direction to the former, but equal intensity. The action of the current is more energetic the more rapid the movement of the armature.

The extra current (it is known) is an induced current which the direct current develops in a conducting wire; it only appears at the moment of a change in the electric state of this. During part of the movement of the armature in Breguet's instrument, the spring continues applied to the screw, and it is only at the end of the movement that separation takes place. The two ends of the bobbin wire are connected, one with the spring, the other with the screw; thus, while contact lasts, the extra current is not manifest. We have therefore to consider two different moments. (1). The armature is separated from the polar surface, but contact between screw and spring persists. (2). Both armature and spring are separated.

At the moment of withdrawal of the armature the poles are displaced, and an induced current is developed in the bobbins; but, the circuit being closed by contact of screw and spring, this current gives no manifestation in the exterior circuit, owing to the considerable resistance it meets. This induced current has produced a second, the extra current, by induction on the wire itself.

The movement of the armature continues; the poles, displaced more and more, produce a stronger current, and then the spring separates from the screw. The current, no longer finding passage in the short circuit, traverses the conducting wires. The secondary current, developed after the first movement, is manifested with energy in consequence of the sudden interruption, and as it is in the same direction as the first, it adds its effects to it.

When this contact of the short circuit is broken, the current is sent into the line; and not only the current produced during the after movement, but the extra current produced during the first part of the movement. (Experience will determine how spring and screw must be placed so as to obtain a current of maximum intensity).

MM. Roussel and Delambre have disputed the existence of the extra current, but (on various accounts) their conclusions cannot be admitted. The galvanometer is unfitted for measuring the force of the extra current, for (as is known) the influence of an electric current on the needle varies in contrary direction to the rapidity of the discharge. Hence the galvanometer communicating with the Breguet apparatus shows a number of degrees less, when there is interruption, the inertia of the needle not having time to be overcome during the short duration of the current. If the interrupter be suppressed, the current develops only gradually in the long circuit; it cannot, as in the preceding case, circulate round the bobbins, and, in proportion as the intensity augments by withdrawal of the armature, it acts on the magnetised needle.

Coming now to *electric batteries;* those for inflammation of tension fuses (of the Abel class) produce explosion with a current of high tension and weak quantity made to act on a conducting powder. Abel mentions as sometimes convenient, the use of the Volta pile with 150 couples; the elements, separated by a ring of flannel impregnated with acidulated water, are held by a screw, which is undone when the pile is inactive. The metallic rings are about 61·7 centimetres diameter.

The Leclanché battery, of the smallest model, is suited for the same application, by its constancy and electromotive force. (The authors describe a modification of it they have devised for the purpose.)

The Daniell and other batteries can be used. The ingenious arrangement of sulphate of copper elements adopted by M. Trouvé in his electro-medical apparatus, also gives good results. The elements, arranged in tension, are fixed in a planchette of hardened caoutchouc. To put the pile in action, the elements are immersed in water for several minutes, and enclosed in a caoutchouc case. The water absorbed by the porous rings surround-

ing the elements keeps the battery in action several months.

Of batteries for inflammation of platinum wire fuses, the ordinary Bunsen pile, with nitric acid, produces acid vapour, and is rapidly used out. The use of a saturated solution of bichromate of potash in a porous vessel gives this battery a duration of about eight to ten days, and is not attended with any liberation of gas. Its electromotive force, though considerably weakened, is sufficiently great for the purpose in hand. This pile, so arranged, is the only one suitable for explosion of automatic torpedoes, where the circuit is closed by the shock against the ship. It is exempt from phenomena of polarisation.

The Leclanché battery, again, may serve for the inflammation of platinum wire fuses in many cases. This battery does not appreciably wear out while inactive. Its constituent parts are a zinc cylinder, a porous vessel containing bioxide of manganese and retort charcoal, and a saturated solution of chlorhydrate of ammonia. The battery is of nearly absolute constancy, on condition that the resistance of the circuit is exactly the same as that of the battery; but, in these circumstances, the production of electricity is weak, and quite insufficient for inflammation of fuses. If only a feeble resistance be introduced into the circuit, the pile furnishes a greater quantity of electricity, but is rapidly polarised, and this polarisation persists till all the hydrogen has been consumed by the bioxide of manganese. Hence the more energetic the effect sought from this pile, the more time it will take to return to its first intensity; and if the circuit is accidentally closed by any cause, the action of the pile will cease for a longer or shorter time. To this, no doubt, may be attributed the little success of the pile in application to torpedoes, which require apparatus of assured action, however long the time of accidental closure of the circuit.

With proper precautions, however, we believe the Leclanché pile may be utilised advantageously in the present connection. For application in war and in mining industry, the zinc surface may be considerably augmented. M. Gaiffe has constructed Leclanché piles of large model; the cylinder of zinc being replaced by a plate of the same metal about 5 c.m. broad. Absolute precision for the moment of inflammation is not so much required in industrial operations. MM. Leclanché and Bautier have lately replaced the porous vessel by a cylinder formed of a mixture of bioxide of manganese and charcoal compressed in a hydraulic press. Thus one avoids the use of fragile vessels, while conserving the properties of the battery, and the electromotive force is considerably increased. The Leclanché battery may be easily employed, when the electric post is not subject to frequent displacement.

There is a class of batteries in which contact of the elements with the liquid is only effected when the battery is to be used.

Of these, the simple and economical Wollaston pile (with $\frac{1}{10}$th sulphuric acid) does not give energetic effects, unless with large surfaces of zinc. The Ruhmkorff pile, as we have sought to improve it, consists of two parts, a vessel of hardened caoutchouc, and a plate of the same material, supporting the elements. Perpendicularly to the plate are fixed, with screws, a series of plates of hardened caoutchouc, intercrossed so as to form a series of prismatic cases of square section; the compartments are open at their lower part, and pierced at their upper, so as to permit escape of air. In each is fixed a plate of zinc held by a screw. The positive elements are formed of thick plates of charcoal placed on the partitions, and resting below on a ledge of hardened caoutchouc, covered with a fragment of vulcanised caoutchouc. Along the axes of the charcoal pieces, a hole is bored, into which we introduce a small lead cylinder closed at one extremity, and into this penetrates a binding screw fixed on the plate. The lead is to protect the screws from contact with the liquid, which often penetrates the charcoal pieces by capillarity. It will be understood that the charcoal held on three sides cannot be broken by shock. Suppose the vessel filled with the bichromate of potash solution, and the troughs immersed some centimetres in the exciting liquid. The elements all communicating together, by the liquid, the current has but feeble tension; but when the battery reaches the lower part of the vessel, the elements are separated from one another, and act in tension. The separation of the compartments is effected by means of a plate of caoutchouc placed at the bottom of the vessel. A battery of this kind, with 9 elements, is amply sufficient for all military operations, and will inflame simultaneously several fuses of average resistance.

M. Trouvé has modified the Marié Davy sulphate of mercury pile, and constructed elements of small size, effecting simultaneous inflammation of several fuses. They are formed of a hollow cylinder of hardened caoutchouc, on the surface of which is cemented the charcoal.

For the case where the circuit must be closed either by the shock of a ship against a torpedo, or passage of the enemy by a particular point, we have constructed an automatic pile (of the class now under consideration) which has some similarity to an English arrangement. (For this the reader is referred to the original.)

In all industrial applications which require a frequent displacement, the bichromate pile with a single liquid is evidently that which, with small form, furnishes the most energetic effects. M. Gaiffe has adopted the following arrangement, which fulfils the conditions of economy and solidity. The elements, formed of plates of zinc and of thick and short pieces of charcoal, are fixed by means of screws, on a board of wood furnished with two handles, and the communications established by movable plates of copper. The solution of bichromate is contained in sandstone vessels arranged side by side. The surfaces of the zinc plates is about 30 square centimetres; and 150 to 200 c.c. is introduced into each vessel. These piles are easily repaired, and do not require any special precautions. The dimensions may be reduced so as to render it portable.

[We propose to recur to this paper of MM. Champion Pellet and Grenier, and give some of their observations on the theory of fuses.]

PRACTICAL INSTRUCTION IN ELECTRICITY AND MAGNETISM, AT THE SCIENCE SCHOOLS, SOUTH KENSINGTON.

Through the kindness of Dr. Guthrie we are able to give details of the course of practical instruction in Electricity and Magnetism now given at South Kensington. In conducting these practical courses, Dr. Guthrie has, from time to time, had the co-operation of Prof. W. F. Barrett, Prof. G. Carey Foster, Prof. Goodeve, Mr. Haddon, Prof. Pedler, Dr. Pike, Prof. Maxwell Simpson, Mr. W. J. Wilson, and Dr. Wormell. For Science teachers the courses on Light and Heat have been somewhat extended, and Dr. Guthrie hopes next year to be able to extend Molecular Physics, Sound, Electricity, and Magnetism in a similar way.

The Student is directed to make the following apparatus:—

(*a*.) A glass tube for electric excitation.

Glass tube about 18 inches × $\frac{3}{4}$ inch. Thoroughly clean and dry inside (this is very important), close and round one end, fuse edges of other end.

(*b*.) Amalgamed silk rubber.

Piece of felt 6 inches square. Thoroughly dry and warm; while warm moisten with paraffin oil in which a little solid paraffin has been dissolved. Dry off the oil as much as possible, then cover on both sides with silk. Smear on one side some amalgam mixed with no more lard than will just suffice to make it adhere, dusting a little dry amalgam over.

(*c*.) Balanced glass tube.

Glass tube about 12 inches × $\frac{3}{4}$ inch. Clean and dry inside, close and round one end, nearly close other end. Balance on edge of triangular file, mark centre with file. Soften one side of tube at centre in Bunsen burner, push in side with point so as to make conical cap. *Avoid* having file scratch at apex of cap.

(*d*.) Pith balls, and attach insulating threads to some of them.

Cut balls roughly to shape with knife, finish with file or glass paper. Thoroughly dry and warm silk thread; while warm immerse in melted paraffin. Wipe off as much paraffin as possible. Attach to pith ball.

(*e*.) Proof plane.

Circular disc of gilt paper about 2 inches diameter, fastened on end of strip of varnished glass.

An electrified body attracts and is attracted by unelectrified bodies.

Glass tube rubbed with silk, sealing-wax rubbed with flannel, hot brown paper rubbed with clothes'-brush, and paraffined paper rubbed with fingers, all attract light bodies; the excited paper adheres to wall, paper and excited balanced tube are attracted by hand.

Show the existence of two electricities.

Suspended pith ball when repelled by excited glass is attracted by excited sealing-wax, and *vice versa*. Two excited glass rods repel each other, two excited shellac rods also repel each other, but excited glass attracts excited shellac.

Make a gold-leaf electroscope.

Clean and dry glass flask, fit with cork, bore cork and fit with piece glass tube about 1 inch long. Cut zinc disc $1\frac{1}{2}$ inch diameter (or use a penny piece), drill and solder to it a straight brass wire 9 inches long. Drill hole in edge of disc. Fill tube, previously cleaned and warmed, with clean shellac (or mixture of shellac and common resin), warm wire and push through. The efficiency of the instrument depends on insulation by shellac; great care must therefore be taken to get rid of all dirt or moisture. Fix glass tube in cork, varnish outside of glass. Clean wire and bend lower end round into a hook, horizontal part being about $\frac{3}{4}$ inch long and flattened to receive gold leaves. Cut two strips of Dutch metal, say 3 inches × $\frac{1}{4}$ inch wide. Gum each side of hook and take up leaves. Shade from air-currents and place in flask.

Test insulating power of metal, wood, twine, sealing-wax, glass, paraffin, &c.

Charge electroscope, connect one end of substance with earth, bring other end into contact with cap of electroscope; note time in which electroscope loses its charge in each case. Note difference between substance used in its ordinary condition and same substance carefully dried.

Excite conducting bodies, and determine quality of electricity.

Hold end of wood or metal rod in piece of vulcanised india-rubber sheet, excite rod by rubbing with fur or india-rubber; test kind of electricity on rod.

Show that rubber is excited with opposite electricity to that of body rubbed.

Make small proof plane with flannel instead of gilt paper, rub sealing-wax or gilt-paper carrier with the insulated flannel; test kind of electricity on each.

Show that kind of electricity depends on rubber.

(*a*.) Rub sealing-wax with flannel and with gun-cotton.
(*b*.) Rub brown paper with india-rubber, with flannel, and with brush.
(*c*.) Rub ebonite with silk and with amalgamed silk. Test kind of electricity developed in each case.

Make spherical, cylindrical, and conical conductors.

Coat wood ball with gilt paper or tin-foil, and attach paraffined silk thread. Make cardboard tube about 6 inches long, covered with gilt paper, and of such diameter that the ball just fits into it, and forms spherical end. Make gilt cardboard cone about 6 inches long, to fit ball in similar way. Silk threads are to be attached to cylinder, and cone for suspending them.

Determine relative distribution of electricity on various parts of surfaces of above conductors.

Insulate and charge conductor. Test with small proof plane and electroscope.

Show that a point discharges electricity.

Attach fine sewing needle to insulated conductor, charge conductor by glass rod and proof plane. Test condition by proof plane and electroscope. Repeat experiment without the point.

Examine condition of insulated ball under induction.

Suspend ball, bring excited glass near, examine near and distant sides of ball with carrier and electroscope.

Charge insulated conductor with negative electricity by induction.

Bring excited glass near, touch conductor with finger, remove finger, then remove glass. Test electricity. Ascertain whether the part of the ball at which it is touched makes any difference as to quality of electricity which remains.

Charge electroscope by glass rod (*a*) with negative, (*b*) with positive electricity.

(*a*.) Charge by induction as in the preceding.
(*b*.) Charge by conduction with proof plane. Test quality in each case.

Show that electricity is found only on the exterior of a hollow body.

Suspend hat by insulating threads, charge with glass rod and large proof plane or by induction. Test inside and outside with proof plane and electroscope. Note large accumulation found round edges.

Prove that result found above arises from induction by surrounding bodies.

Test condition of table, &c., near charged hat. Place large conducting ball, earth connected, inside of hat, but not touching it. Now test inside and outside of hat.

Make insulating plate.

Glass plate 10 inches × 8 inches. Thoroughly clean, warm, and varnish with shellac on both sides. Attach silk loops as handles.

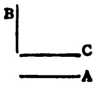
Arrange and illustrate action of a condenser.

Lay piece of tin-foil $7\frac{1}{2}$ inches × 6 inches, earth connected, on table; on this lay insulating plate (the preceding), and on plate a second sheet of foil connected by wire to electroscope. Charge upper foil with proof plane until leaves just begin to diverge; cautiously lift plate and upper foil. Repeat experiment, lower foil being insulated.

Construct and use a Bennett's multiplying condenser.

Cut three sheet zinc circular discs, each about 3 inches diameter, round and smooth edges, and fit each with varnished glass handle (like an electrophorus plate). On other side of one disc (A) drop three little spots of sealing-wax. Fix handle of this disc in wood block so that disc is insulated with spotted side uppermost. Connect it by wire with electroscope. Now give A a very small charge of electricity. Lay B on A, and momentarily touch B. Remove B, lay C on A, and

momentarily touch C. Place B in contact with C thus—



and momentarily touch A. Remove B, then C. Place B on A, and momentarily touch B. Place C in contact with B, momentarily touch A, and so on, repeating operations ten or twelve times. In this way a charge far too small to affect gold leaves may be multiplied to any extent.

Make a Leyden jar with movable coats.

Paste piece of tin-foil or metallic paper, 8 ins. × 15 ins., on card. Clean and dry glass jar. Cut tin-foiled card into two strips 4 inches wide, and cut off from each strip length fully sufficient to go round jar. Make outside and inside cylinders, using surplus pieces for bottoms. Cut two strips of tin-foiled card 3½ inches × 1 inch; bend ends, and paste across top and near bottom of inside cylinder at right angles to each other. Cast lead bullet on brass wire 9 inches long; pass wire through upper cross-piece of card, and attach to lower cross-piece by a cork. Clean, warm, and varnish outer exposed surface of jar.

Make a simple discharger.

Cast lead bullets on ends of piece of stout brass wire about 6 inches long, solder piece of brass tube ¾ inch long to middle of wire. Fix glass handle in tube with shellac or resin.

Charge and discharge jar.

Outer coating being connected with earth, charge knob with glass rod and carrier, use discharger.

Investigate process of charging jar.

Insulate jar, charge knob with positive electricity, and test outer coat; the repelled positive will be found upon it. Connect outer coat momentarily with earth, then connect knob with earth and test outer coat; a free charge of negative will be found. Remove free negative charge and test knob; it will have a free positive charge.

Show that the charge given to jar is merely distributed by coatings to outer and inner surfaces of glass.

Charge jar, remove and test coatings, replace and discharge.

Charge jar negatively from positive source.

Insulate jar, connect inner coat with earth, charge outer coat. Insulate inner and uninsulate outer coat. Test knob for free negative charge.

Gradually discharge positively and negatively charged jars by pith ball carrier.

Place knobs of jars 5 or 6 inches apart, suspend insulated pith pall between. The ball will oscillate between the knobs, gradually neutralising the electricity of one with that of the other.

Make a Thomson's quadrant electrometer.

Circular disc of glass 5 inches diameter, with 1 inch circular hole in centre. On one side of this fasten with gum four tin-foil quadrants, leaving ⅛ inch space between edges of quadrants and between quadrants and inner and outer edges of glass. Connect opposite quadrants by slips of tin-foil or fine copper wire passing underneath. Thoroughly clean, warm, and varnish uncovered portions of glass. Support it on four pieces of stout barometer tube, each about 3 inches long, fixed vertically in circular disc of wood. Each pair of quadrants is to be connected by wire with insulated knob on wood base; the connecting wires may pass down two of the supporting tubes. The glass disc may be fastened on tops of tubes with shellac, or a short piece of brass wire may be cemented into top of tube, projecting slightly, so that a shoulder is formed on which edge of disc may rest. Make light flat needle of thin gilt card, zinc-foil, or aluminium, 4 inches long, with rounded ends, narrow at middle (somewhat like a dumb-bell). At right angles to centre of needle fix stouter slip of card or metal, about ⅛ inch wide × ¾ inch long; to upper end of this a fine silk fibre is to be attached, and on it—at right angles to axis of needle—a mirror of microscope glass, about ⅝ inch diameter, is to be fixed. A small piece of magnetised steel is to be cemented on back of mirror. To lower side of needle, and in metallic connection with it, a very fine platinum wire about 2 inches long is to be attached. On centre of wood base under glass disc is to be placed a glass vessel about 1½ inches high × 2 to 3 inches diameter, containing strong sulphuric acid, the outer surface of glass being coated with tin-foil, so as to form a Leyden jar. The tin-foil must be connected with earth, and a wire with platinum end dipping into the acid and leading to an insulated knob will serve to charge the jar. The needle is to be suspended by silk fibre from varnished glass stem, so that it swings over quadrants as near to them as possible without touching, the platinum wire dipping into the sulphuric acid. To use the instrument, the Leyden jar is to be charged, the knob of one pair of quadrants connected to earth, and the charge of electricity communicated to knob of the other pair. The needle must of course swing so that its axis is over dividing line between pairs of quadrants. Small motions of the needle are rendered visible by throwing on the mirror a small beam of light, which is reflected by it to a graduated white screen at some distance.

Magnetise sewing needle by discharge of jar through coil of wire.

Make a small coil of wire on end of glass tube; cover with shellac. Place needle within and discharge jar through coil of wire. Note direction of current through coil and consequent polarity of needle. Ascertain poles of needle by floating it on water. Suspend needle by fine thread from centre and keep for use.

Magnetise soft iron wire with voltaic current, and compare results with preceding.

Connect copper plate to end of wire coil previously connected with positive coat of jar and zinc plate to other end. Immerse plates in dilute acid and place iron wire in coil. Test its polarity with suspended magnetised sewing needle.

Examine action of current on magnetic needle.

Place zinc and copper plates in dilute acid, connect by copper wire. Place suspended needle above, below, and on each side of wire. Observe deflection in each case. Placing zinc and copper plates at sufficient distance apart, examine direction of current through the liquid.

Make astatic galvanometer.

Wind about 50 feet of fine covered copper wire on wood block; remove wood; secure coil by tying with thread; insulate and stiffen coil by soaking with melted paraffin or shellac varnish. Make another similar coil; fix the two coils side by side on round wood block, leaving about ¼ inch space between them and soldering two of the free ends of coils together so as to make one continuous coil. Solder other two ends of wire to binding screws fixed about ⅛ inch from edge of block. Lead ends of the wire also into two little hollows cut in wood block by side of binding screws, so that these depressions may serve as mercury cups: they are convenient for shunting the galvanometer. Bend stout brass wire into flat topped arch and fix firmly in block; the straight portion of wire at top of arch having upon it a cork roller for raising or lowering needles. Magnetise two sewing needles and fix (with opposite poles adjoining) ¼ inch apart by means of twisted fine copper wire. On same axis, ¼ inch above upper

needle, fix glass thread about 4 inches long to serve as pointer. Suspend needles by silk fibre and attach fibre to cork roller. Cut card into circle 4 inches diameter and graduate circumference into degrees. Place (but do not fix) card in proper position over coil, supporting it on two corks cemented to board. Make needles as far as possible astatic. Place them in position and cover all with glass shade.

Test delicacy and determine zero of galvanometer.

Solder wires to ends of a pin and a needle, join up to galvanometer, push couple through cork so as to expose ½ inch of each metal. Dip into water and note deflection. If necessary, dissolve some salt in the water or acidulate it, or if deflection too great shunt the galvanometer. Reverse current and again note deflection. Repeat once or twice. Take mean of difference of deflections and move zero of card accordingly. Now fix card in position.

Make a Daniell's cell.

The materials to be used are:—The glass vessel used for Leyden jar, porous cell 4½ in. × 1½ in., zinc plate 8 in. × 5 in., copper strip 4½ in. × 1½ in., 2 binding screws, copper wire, large bung which fits glass jar. Bend zinc into cylinder 3 in. diameter × 5 in. high, attach it firmly to the bung by means of one or more pieces of copper wire soldered to zinc and passing up through bung, connect zinc also by soldering with binding screw fixed on upper side of bung. Similarly secure copper strip to the other binding screw fixed on centre of bung. Place porous cell in glass jar, nearly fill porous cell with saturated solution of cupric sulphate and fill outer jar to same level with dilute solution of zinc sulphate. Place plates and cover in position. Connect binding screws by short piece of wire and test existence of current in the wire by magnetised sewing needle.

Note.—The bottom of glass jar not being flat and jar being too deep, put some clean sand in bottom for porous cell to stand upon. It will improve porous cell if bottom and ½ inch of edge be soaked with paraffin. Put solutions back into bottles and wash plates of your cell every day when done with.

Make a Wheatstone's bridge.

Board 2 ft. × 4 in., two strips of copper 3 in. × ½ in., and one strip 15 in. × ½ in. Solder one end of copper wire to centre of each strip, using wires 30 inches and 10 inches for short strips and 15 inches for long one. Fix short strips of copper at right angles to board and 1½ inch from each end; lead wires under board and up through one end, leaving loose ends to join to galvanometer. Fix long strip on board ½ inch from edge, lead wire from it under board to binding screw at far end. Solder a stretched German silver wire to short copper strips. Under German silver wire fix a paper scale same length as wire and carefully divided into 100 equal parts. (It will be useful to subdivide these into 5; if the scale be ½ metre long the large divisions will be ½ centimetres and the small ones millimetres). Solder binding screw on each end of long copper strip and on adjoining end of each short strip.

Measure relative resistances of different lengths of the same copper wire by Wheatstone's Bridge.

Insert two different lengths A and B of the same wire in the two gaps of bridge, join end wires of bridge to galvanometer, attach one wire of your cell to middle binding screw of bridge and lightly touch German silver wire with extremity of other cell wire. Find place on divided German silver wire where such contact causes no deflection of galvanometer. Then the lengths of the two portions of the German silver wire are in the same proportion to each other as the resistances of A and B.

Find lengths of copper wires by measuring their relative resistances, the length of one of the wires being known.

Measure relative resistances as above; the wires being all of the same diameter and material, the lengths are in direct proportion to resistances.

Ascertain relation between resistance and weight.

Two copper wires of same length and of known but different weights being given to you, measure their relative resistances, and state relationship required.

Ascertain effect of temperature on resistance.

Accurately balance two copper wires in bridge; heat one of them and note effect on needle. Shorten other wire and so ascertain whether effect of heat was to diminish or increase the resistance, and by how much.

Experimentally establish the laws of divided circuits.

Insert 1 foot of fine copper wire in one gap of bridge, in other gap insert (*a*) 2 feet of similar copper wire, (*b*) 2 feet of iron wire. Balance each against the copper standard; note ratios. Now put both the two lengths of copper and iron together and balance, once more noting ratio. From your measurements, show the truth of the formula, combined resistance = $= \frac{G+S}{G \times S}$, where G equals the 2 feet copper wire, and S the iron wire.

Make a rheochord.

Board 2 ft. × 3 in. Two uprights of wood 1 inch high firmly let into board ½ inch from each end. Cut off 1 inch of glass tubing having clear ½ inch internal diameter. Fit with small corks at each end, through which are bored two wire holes ½ inch apart. Thread the ends of steel wire through corks, then fill tube with clean mercury. Strain the steel wire in two equal lengths across to each upright, the wires being parallel, ½ inch apart and about ½ inch above board. Connect one end of wire to a binding screw, the other to a mercury cup ½ inch diameter and ½ inch deep sunk in board. Measure the resistance of your whole wire and make paper scale under wire, the scale being so divided as to indicate decimal parts of a unit.

Make a set of resistance coils.

Measure off (by bridge) lengths of silk-covered German silver wire having resistances of 1, 2, 2, 5, 10, 20, 20 units. Wind each length of wire on a cork or cotton reel and soak wire on it with melted paraffin. Make six more mercury cups 1½ inch apart, like the one already made, in a row along one edge of board of your rheochord. Fasten the bobbins of wire along other edge in a row opposite interspaces between mercury cups. Lead one end of first coil of wire under board and up into first mercury cup, securing it below with a little shellac. Lead second end of first coil and likewise first end of second coil into second cup; second end of second coil and first end of third coil both into third cup, and so on. Make seven thick copper wire staples 1½ inch long and turned down ½ inch each end for connecting cups. Mark value of coil connected with each pair of mercury cups on board between them. Fill cups with mercury. Amalgamate loose copper connections. Note down temperature of room wherein coils were measured.

Construct a commutator.

In block of wood 4 inches square cut four parallel troughs ½ in. × ½ in. × 1 in. long and ½ inch apart in centre of board. Fix on cork two pieces of copper wire bent so as to dip into troughs, connecting first trough with second, and third trough with fourth. On opposite side of cork fix two other pieces connecting first trough with third, and second with fourth. Mount cork on horizontal axis over troughs

so that it can revolve and each set of wires dip in turn into mercury in troughs.

Measure internal resistance of your cell.

Make a circuit of resistance coils, rheochord (both short circuited) cell and galvanometer. Shunt galvanometer so as to get deflection of say 20°. The total resistance of circuit is now approximately that of cell $=x$. Put in resistance by coils or rheochord until the deflection is reduced to, say 15°. Suppose this resistance to be $2\frac{1}{2}$ units, the whole resistance of circuit is now $x+2\frac{1}{2}$. The current being inversely as the whole resistance you have—

$$15^\circ : 20^\circ = x : x+2\tfrac{1}{2}.$$

Note.—In this experiment the current strength is assumed to be proportional to the angle of deflection. When the deflection does not much exceed 20°, the error is inconsiderable.

Compare electromotive force of your cell with that of a Grove's cell.

Make a circuit of your cell, resistance coils (short circuited), and galvanometer. Shunt galvanometer so as to obtain deflection of, say 40°. Introduce resistance so as to reduce deflection to, say 35°. Note the amount of resistance required to do this. Take out your cell and put in the Grove's; arrange circuit by putting in resistance so as to get again same deflection of 40°, reduce deflection by resistance again to 35°, and note how much introduced. The electromotive forces of the cells are in the proportion of resistance required to reduce deflection 5° in each case.

Measure internal resistance and electromotive force of two or more cells arranged in series; also when arranged in multiple arc.

Make a thermopile.

Cut twenty-four pieces thick steel wire 1 inch long; harden twelve of them by heating to redness and dipping into cold water. Cut twenty-four parallel grooves in slip of wood 3 in. × $\frac{3}{4}$ in. × $\frac{1}{4}$ in., and lay hard and soft wires alternately in grooves. Screw another similar slip of wood on top so as to hold wires in position. Solder alternate ends of wires together with easily fusible solder. Solder short lengths of copper wire to terminal steel wires.

Make two bar magnets.

Two steel strips 4 in. × $\frac{3}{4}$ in. × $\frac{1}{4}$. Cut ends square and clean. Harden strips by making them bright red hot, and dipping into cold water. Brighten portion of surface of steel by grinding. Lay steel on a piece of red-hot iron or hold it in large Bunsen flame until bright surface turns yellow, drop at once into cold water. Magnetise by drawing one pole of bar magnet along each. Note polarity produced, and mark ends with coloured paper. Keep magnets with opposite poles adjoining and connected by soft iron keepers.

Obtain magnetic curves.

Place pair of bar magnets on white paper and sheet of glass above. Sprinkle iron filings from muslin over glass, and tap surface. Try in this way various combinations of poles with bar and horse-shoe magnets.

Fix magnetic curves.

(*a*). Make a solution of gall nuts. Brush over sheet of paper with solution; remove superfluous moisture by blotting paper. Place damped paper over curves, press evenly, carefully lift paper; dry quickly, and shake off filings. A permanent impression in ink will be left on the paper. (*b*). Fix pair of magnets to one side of square of glass, coat other side with very thin gum water; when plate is quite dry, dust fine iron filings over gummed surface, tap, then breathe gently on plate. Gum is thereby softened and curves fixed.

Determine distribution of power along a bar magnet.

Magnetise long steel knitting needle, try by filings whether intermediate poles be present, if so re-magnetise and get rid of them. Magnetise a sewing needle and suspend it by silk fibre attached to its centre. Determine number of oscillations suspended needle makes per minute under influence of earth alone. Call this number "*a*." Fix knitting needle magnet vertically, and determine number of oscillations sewing needle makes at uniform distance (say 1 inch) from various points along vertical magnet from end to end. Call these numbers *b*, *c*, *d*, &c. Then b^2-a^2, c^2-a^2, &c., express relative magnetic intensities of the various points. Plot out the curve of distribution of free magnetism from your number thus obtained.

NOTES.

The advantages of the electrical arrangement of Messrs. Stroudley and Rushbridge for communication between passenger and guard or driver, now in use on the London, Brighton, and South Coast Railway, are obvious. A handle in each compartment of the train is connected to a battery and bell in the guard's van. The handle, when pulled out, can only be put back by a key which is in the possession of the guard, and until this is done the ringing of the bell continues. A slip coupling is provided for disconnecting part of a train when it is desired to leave a carriage at a station without stopping. The cords hitherto used by the Brighton Company can also be connected to the electric arrangement. A push is provided for the use of the guards, and by means of a small slide the bell at the other end of the train can be kept ringing: the guard's hands being thus liberated he can, if necessary, apply the break. The system was described by Mr. W. Smith, C.E., at the Bristol Meeting of the British Association.

The work done by the combination printing telegraph instrument seems to be very satisfactory. The Editor of the *New York Telegrapher* is informed that the four printers and four operators in the Boston circuit, duplexed, actually accomplished more work than the quadruplex Morse with eight operators and eight expensive sets of apparatus.

Respecting the rumours of pending amalgamation of the Atlantic and Pacific Telegraph Company with the Western Union Company, President Orton writes:—"The Western Union Company can use to advantage, and may absolutely require, within the next twelve months, 10,000 miles of additional wires. If these additional facilities can be acquired by companies now using them in competition with us cheaper than we can erect them, clearly it would be for our interest to buy out such companies rather than to erect new wires. But we have made no proposition for the purchase of any competing lines, and no proposition has been made to us that would be for the interest of the Western Union to accept."

Arrangements are being made at Newark, N.J., for the establishment of a Law-Reporting Telegraph Company, to

connect with offices of all legal gentlemen who become subscribers. Each subscriber will control a separate wire to communicate with the courts, and can be placed in instant communication with any law firm in the city using the telegraph. At each office will be placed a printing telegraph instrument, which can easily be operated, and capable of transmitting and receiving from fifteen to twenty words per minute.

The American District Telegraph System is now being introduced into New Orleans.

It has been proposed that there shall be, during the Centennial Exhibition at Philadelphia in 1876, a telegraphic tournament, which shall be open to all operators who may wish to compete with suitable medals and prizes for such as shall excel in expertness in transmitting and receiving by telegraph.

The following statement shows the attendances and money received during the meeting of the British Association at Bristol:—Old life members, 240; new life members, 36 (£359); old annual members, 296 (£296); new annual members, 93 (£186); associates, 884 (£884); ladies, 672 (£672); foreign members, 17. Total attendances, 2249; total money received, £2397. The grants for subjects connected with Mathematics and Physics were the following:—Professor Cayley, Printing Mathematical Tables, £159 4s. 2d.; Mr. Brooke, British Rainfall, £100; Mr. J. Glaisher, Luminous Meteors (£25 renewed), £30; Professor C. Maxwell, Testing the Exactness of Ohm's Law (renewed), £50; Professor Stokes, Reflective Power of Silver and other Substances (renewed), £20; Professor Tait, Thermo-Electricity (renewed), £50; Sir W. Thomson, Tide Calculating Machine, £200.

In a paper read before the Auckland Institute on the best route for a submarine cable between Australia and New Zealand, Dr. Purchas gives a preference to the route from Botany Bay to Ahipara Bay, near the North Cape, Auckland. The bay, he stated, was easy of access, sandy, and sheltered from a current which swept round the North Cape, the soundings showing an average of 750 fathoms along a ridge which seemed to extend from the North Cape right across to Australia. One fatal objection to the route from Botany Bay to Cape Farewell was that soundings which had been made showed the enormous depth of 2600 fathoms. The cable would also land on the wrong side of Cook's Straits, the seat of Government being on the opposite side.

The telegraphic service, since it was first established in France, has never until the present year been worked at a profit. Down to 1873 the cost always exceeded the receipts, the deficits having varied from 500,000 f. to 4,500,000 f. annually. In 1874 the expenditure was just balanced by the income; while for the present year the estimates show a surplus of 2,200,000 f., the outlay being set down at 14,500,000 f., and the receipts at 16,700,000 f. The profits during the first half of the year amounted to about 1,600,000 f.

Negotiations are said to have been opened between France and England for reducing the telegraphic rate between the two countries.

Telegraphic communication has been opened with Gladstone in the northern agricultural districts of South Australia.

An iron telegraph pole has lately been erected in New York. It is said to be lighter than a wooden pole of the same height, stronger, and capable of supporting a greater weight. It is constructed of a number of wrought-iron bars, rolled out the entire length of the pole, which bars are placed around light cast-iron cores, arranged at proper intervals from each other. The cores have seats or notches to hold the bars in their places to prevent their moving sideways, and the bars also have notches, into which the cores fit to keep them from moving up or down. Around the outside, where each core is placed, a ring or band of wrought-iron is tightly fitted, which holds the bars firmly in their places. Any number or any size of bars may be used, but it is found that six very light bars of angle iron arranged in this way afford a strength that fully meets that required for a telegraph pole of 50 feet in height. The cores are large at the base and are made smaller as they approach the top, which gives the column a graceful taper, and the whole is surmounted by a suitable crosshead to hold the arms for the wires.

The Direct United States Cable is now said to be in good working order throughout, and its insulation perfect. The line will be open for the transmission of messages on the 15th inst. The tariff for day messages to New York will be 2s. per word, but for night messages a reduction of 10d. per word will be made.

CORRESPONDENCE.

THE GOVERNMENT TELEGRAPHS.

To the Editor of the Electrical News.

Sir,—Though not practically acquainted with the working of Government telegraphs, yet, as one of the public occasionally sending telegrams, I feel interested in the question how to reduce the expenditure of the service so as to render it remunerative, instead of remaining a financial drain. I have therefore read with much satisfaction your abstracted report of the "Committee" appointed to investigate the matter, and your leading article commenting upon it.

It appears to me that, economy being required, it should be chiefly enforced in curtailing the numerous entries attending each message, made at every station whether large or small; and in simplifying other office work undertaken, apart from actual transmission of the message. I am informed that during the old companies' management the despatch of a message did not entail more than a small fraction of the registering, &c., now effected.

Regarding the closing of those offices which do not pay their expenses (hinted at by the committee), and, speaking as one of the public, I think such a suggestion ought not for a moment to be seriously entertained, as, from the committee's own showing, the number of such unpaying offices is very rapidly decreasing. In their

report they show that out of a total number of 3444 offices in 1872, 728 did not pay; and of 3692 in 1874, only 449 were in a like state. In other words, the percentage of unremunerative offices in 1872 was 21·14 against 12·16 in 1874—a reduction so great that the returns for this year may prove all of them to be profitable.

Neither ought we to pay for addresses. My reason is that such a charge would fall heaviest on the poorer classes who live in localities where long addresses are frequently imperative. Let those who transmit arrange for a method of minimising the labour of signalling "addresses" and "service instructions;" and if any alteration be declared to average a greater number of words than the body of the message made in the tariff, let it be a reduction in the cost of the message itself (to encourage remunerative work) rather than an increase.

Would it not be a good plan to forward to the receiver only the name of the sender? This is frequently done in *foreign* messages where the tariff is high, and I have heard of no instance of confusion arising therefrom. If the sender then insists upon his full address being despatched, he might in all fairness be charged a small fee.

The present system of telegraphs is such a boon to the public, and is so necessary to society, that it will never do to introduce rules curtailing its benefits. If the worst comes to the worst let us accustom ourselves to bear a yearly deficit for the sake of the enormous conveniences placed within the reach of all.—I am, &c.,

One of the Public.

August 27, 1875.

ELECTRICAL SCIENCE IN FOREIGN JOURNALS.

(This column is devoted to a list of Electrical Memoirs published in Foreign Journals. Those of importance will be either translated in full or given in abstract.)

Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, tome lxxxi., No. 8, August 23, 1875.

Moniteur Industriel Belge, No. 53, September 1, 1875.

Neither of the above journals contain anything suitable for our columns.

Les Mondes. Vol. xxxvii., No. 15. August 12, 1875.

Contains a description of MM. Voisin and Dronier's **Electro-Catalytic Lamp-lighter**, which was invented and patented some months ago. Briefly described it is as follows:—A small glass vase contains an exciting liquid, and is placed inside a small wooden box, to the lid of which are attached two carbon plates and a zinc plate. The zinc plate is fastened to a rod projecting through the lid, and is kept above the liquid by a spiral spring, and the poles of the battery are led out from the box over above a small spirit-lamp of highly volatile spirit, such as paraffin; the two poles being connected by an excessively fine piece of platinum wire. When the rod is pressed down, the zinc plate at its end is immersed into the liquid, and the current engendered renders the platinum wire incandescent. The inflammable gas which surrounds the wick of the lamp, being immediately under the red-hot wire, becomes ignited, and the lamp so lighted is ready for use.

No. 16, August 19, 1875.

Lightning Conductors.—The following are the results of investigations undertaken in France by a Commission to study the establishment of lightning conductors on the principal buildings of Paris. (1.) *Points.*—A stem consists of a conductor rising to a certain height above the buildings. The point should have a mass and conductivity sufficient to resist a disruptive discharge. Platinum points were found useless, and the Commission says—"Place at the top of each stem an 'arrow' of pure red copper, about 50 c.m. long, with sides sloping upwards 15° towards its central perpendicular." (2.) *Stems* should be of wrought iron, in one length, slightly conical. They should also be as much as possible galvanised, but under no pretext whatever should they be painted. The jointing between the stem and the conductor should be bolted, and well covered with a thick coating of tin solder. (3.) *Protecting zone of each stem.*—For an ordinary construction the stem efficiently protects *the volume of a cone* having the point for its summit, and the height of the stem—measured from the roof-ridge multiplied by 1·75—for radius of the base. Thus a stem of 8 metres protects a cone whose base, measured upon the ridging, = 14 metres radius, or 1·75 × 8. In practice the stems may be a little further apart, on condition that the "circuit of the roofs" be made use of. (4.) *Circuit of the roofs* means a metallic conductor making a circuit around the ridges of the roof. It must be in metallic connection with the lightning conductors of the building. (5.) Every metallic piece of considerable mass, forming part of the structure, should also communicate with the lightning rods. (6.) The extremity of the *rod* ought to be soldered to a metallic plate or hollow cylinder, of as large a surface as possible, and immersed deeply into water. *When it is not possible to reach a sheet of water the establishment of a lightning conductor must be discarded, as it would prove a source of danger rather than a protection.* (7.) The Commission recommends that conductors be completely inspected at least once a year, towards the end of autumn; moreover, their electrical resistance should be tested periodically by ordinary processes.

No. 17, August 26, 1875.

Contains no records of electrical researches.

Vol. xxxviii., No. 1, September 2, 1875.

Electric Polarisation of Minerals. — By the Count du Moncel.

New Electric Experiments.—D. S. Stroumbo, Professor at the University of Athens.—The electrophorus, as its name indicates, serves to give an electric spark which arises from the influence exercised by the negative electricity (which the rosin disc receives on being rubbed with a cat's skin) upon the neutral electricity of the superposed metallic plate. The lower surface of the metal plate—that which touches the rosin disc—takes positive electricity, and the upper side of the plate negative electricity. Now, these electricities being feeble, the noise and spark resulting from them are very faint; but their presence may be rendered evident to an audience by the following experiments:—(1.) The glass rod being unscrewed from the metal plate, let it be suspended from a ring by four silk threads; and on its central spot place a small metal disc, to which is attached a copper stem whose other end is bent down. From the bent end suspend a small piece of gold-leaf. In this condition place the plate upon the middle of the electrified resin; and instantly the gold-leaf is raised to a vertical position—an effect due to the repulsion exercised symmetrically by the portion of the negative electricity of the plate, and of the uncovered circular zone of the rosin disc. (2.) The gold-leaf being in its vertical and raised position take away the electricity from half of the circular zone of the rosin disc, taking care not to touch the metal plate. We then observe that the gold-leaf slopes towards that denuded portion of the zone, being repelled with greater force from the opposite side. From the remaining side of the zone now take away the negative electricity, and we find the gold-leaf re-adjusts itself to the vertical position. (3.) Change the position of the *small* metal disc by putting it near the edge of the larger one; the gold-leaf then slopes in direction over the edge, and we may cause the inclination to increase or decrease by removing portions of electricity from the zone of uncovered resin.

(4.) Now move the large metal plate (the small one remaining in position as in 3) to the edge of the circular rosin disc; the gold-leaf will be found to assume almost a horizontal direction. (6.) If, when the plates are placed as described in the first experiment, we disperse the negative electricity on the large metal plate, the gold-leaf will return to its suspended position; but take the plate off the rosin disc, and the gold-leaf will again be energetically driven upwards into its vertical position, the positive electricity—which was before at its under surface—distributing itself uniformly over the plate and exercising its repulsive effect. On again touching the metal disc with the finger, the positive electricity is dispersed, and the gold-leaf returns once more to its former state. It is, of course, best to carry out these experiments in a very dry atmosphere.

Repertorium fur Experimental Physik,
Band xi., Heft 2 and 3.

On the Arrangement of the New Physical Institute at the University of Graz.—M. Töpler.

Gramme's Magneto-Electric Machine.—M. Alfred Niaudet Breguet.

Various Apparatus.—Dr. Plettner.—One of these is a relay for school purposes. It can be used as a relay for working current, or as one for constant current; as a Wagner hammer, or a mercury hammer. It is suitable for showing scholars how four different apparatus can be developed out of one, by a simple alteration in the connection of the parts.

Change of Volume of Caoutchouc through Heat.—M. Puschl.—The conclusions M. Puschl arrives at are these:—1. Caoutchouc is a body whose density at a certain temperature is a minimum. 2. The temperature of this minimum varies with mechanical stretching, and is lower the stronger the stretching. 3. With unstretched caoutchouc the temperature of the minimum of density is higher than the ordinary: it therefore approaches to this on heating, and the coefficient of expansion is positive, but with increasing temperature becomes even smaller. 4. With strongly stretched caoutchouc the temperature of the minimum of density is lower than the ordinary: the coefficient of expansion is therefore negative, and increases numerically with the temperature. Caoutchouc is not alone (the author adds) in these respects. Iodide of silver, *e.g.*, and Rose's metallic mixture present similar phenomena.

On a Universal Meteorograph constructed on a New System.—M. v. Rysselberghe.—The author here indicates the principles on which his apparatus is based, and will describe it more fully in a future number. In its most recent form (as constructed by Schubart, and in use at Ostend) the apparatus furnishes, from quarter to quarter of an hour, the readings of a syphon barometer, an August psychrometer, a Saussure hygrometer, a Robinson anemometer, a wind vane, and a rain gauge, while it also gives the height of the sea-level. Electricity is employed in the arrangement.

Results of Magnetic Observations made in Russia in Summer, 1874.—M. Smirnow.—Numerical data of inclination and declination are furnished from forty-two stations.

Studies on the Currents of Electric Machines.—Prof. Rossetti.

Annales de Chimie et de Physique. September.

On the Employment of Zinc as a De-incrustant in the Interior of Steam-Boilers.—M. Desueur.—The author experimented both with salt water and with water from the Loire, containing only some silicates. The zinc disappeared and the tartar was non-adherent. The zinc forms the positive pole, and the iron envelope of the boiler the negative. [The editors, in a note, suggest the inquiry whether it is not the layer of hydrogen gas, incessantly reproduced on the iron surface, which prevents adherence of the deposit, either by hindering intimate contact with the metal, or breaking the pellicles in the moment of their formation, so as to effect a passage.] The proportion of zinc to be introduced is about 20 kilogrms. per 100 horse-power, for three months' duration—a comparatively trifling expense, for one may utilise, for the purpose, parings and *débris* of zinc that are often treated as useless in workshops.

Dingler's Polytechnisches Journal. August 1.

A Proposal for Telegraphic Connection of a Moving Train with the Neighbouring Stations.—M. von Ronneberg.—A telegraph wire between the two stations is held out horizontally, from insulators on posts, by means of a spiral spring, so as to continue in contact with a horizontal grooved metallic wheel, supported by spiral springs, which project—one above the other—from a porcelain plate in the side of the guard's van. The outer parts of these two springs unite to form the axis o the wheel. One of the springs is connected, at its innerf end, with the electro-magnet of an ordinary relay, in the van; and this magnet, through a Morse key and wire, with the axle of one of the rail-wheels (metallic connection being complete between line-wire and earth through the van, when the key is at rest). Two equal batteries, at the two stations, are connected by like poles to the line, thus giving constant currents, through the relay in the van, to earth. When the guard presses his key, the currents of both stations, meeting, pass through the whole length of the line, and, as they are opposite, they neutralise each other; and the armatures of the station-relays, previously held attached by the constant current, are now detached by a spring: thus signals are produced. There is a peculiar arrangement of relays at the stations, which we do not stop to describe.

Automatic Pneumatico-Electric Contact for Railways.—M. Bernstein.—Eight or nine minutes before entering a station, the train is made to announce itself by means of an electric current working a bell. At the point determined, the wheels of the train, in passing, press with their tires on spring rails outside the regular ones; a cross-bar connecting these side rails presses, with a plate on a caoutchouc bellows, thus forcing air through a lead tube into a second bellows, and so causing a spring to complete an electric circuit. [The editor points out that it would be much simpler if the plate were made to act on a contact spring directly.] The apparatus at the station is so arranged that ringing continues till some one presses a key with his finger.

Die feierliche Sitzung der Kaiserlichen Akademie der Wissenschaften am 29 May, 1875. Wien.
[Anniversary Meeting of Vienna Academy.]

In this is given an account of the work of the Academy during the year (a list of the papers read, &c.), with obituary notices of Rochleder, Gottlieb, Schrötter, Argelander, Elie de Beaumont, and Sir Charles Lyell. The Baumgartner prize, for the work which may constitute the most important advance in Physics since the prize was last given, was awarded to M. Boltzmann, for his experimental determination of the dielectricity-constants of a series of substances. [See Electrical News, pp. 22 and 94.] One of the reports states that the central station in Austria, for meteorology and terrestrial magnetism, stood, in 1874, in connection with 151 stations in the western half of the empire—one station to every 36 geographical square miles. Since July, 1873, the telegraphic weather reports have been summed up at the central station in a daily autographic bulletin, which is widely distributed. One of Dr. Theorall's (of Upsala) monographs is now supplied to the central station. It differs from ordinary self-registering apparatus in that, while the latter generally indicate changes of the meteorological elements by curves, the meteorograph prints the numerical values, from quarter to quarter of an hour, in tabular form, on a

paper-covered cylinder; further, the instruments whose data are registered are connected with the printing-apparatus, not by mechanical means (lever and wheelwork), but by galvanic circuits; all owing perfect freedom of choice in placing the several instruments. There had also been obtained a Meyerstein (of Gottingen) magnetic theodolite; an apparatus, by the same maker, for measuring the horizontal component of the earth's magnetism, by the galvanic method; and an Adie magnetograph.

Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften (Vienna), Band lxxi., Heft 1 and 2.

Action of the Muscle Current upon a Secondary Circuit; and a Peculiarity of Induction-Currents that have been induced by a Very Weak Primary Current.—M. Ernst Brücke.—Reserved for separate note.

Different Excitability of Functionally Different Nerve-Muscle Apparatus (Second part).—M. Alexander Rollett.—Reserved.

COMMERCIAL NOTES.

Information has been received by the Cuba Submarine Telegraph Company of the intertuption of Key West Punta Rasa Cable of the International Ocean Telegraph Company. Communications between those points is being maintained by steamer at a delay of about one day. Should the cable not be speedily repaired, the new cable which has arrived out, but is waiting for more favourable weather, will be at once laid.

The Directors of the Indo-European Telegraph Company (Limited) at their Board Meeting on the 6th inst., declared an interim dividend for the six months ending 30th June last at the rate of 5 per cent. per annum, payable on and after the 1st proximo.

The traffic receipts of the Eastern Extension, Australasia and China Telegraph Company (Limited) for the month of August last amounted to £20,072, and for the corresponding month of 1874 to £19,697.

The number of messages passing over the Cuba Submarine Telegraph Company's lines during the month of August was 2279, estimated to produce £2200, against 1750 messages producing £1622 in the corresponding month of last year.

TELEGRAPH SHARE LIST.

Amount per Share.	Name of Company.	Amount paid up.	Closing Quotations.
£		£	Sept. 8.
Stock	Anglo-American	100	53—53½
10	Black Sea	All	2—4
10	Brazilian Submarine	All	6¼—6¾
10	Cuba	All	8—8½
10	Ditto, 10 per cent Preference	All	13½—14½
10	Direct Spanish	9	5¾—6¼
10	Ditto, 10 per cent Preference	All	11¼—12¼
20	Direct United States Cable	All	9¾—10¼
10	Eastern	All	6¾—7¼
..	Ditto, 6 per cent Debenture	..	103—106
10	Ditto, Exten. Australia and China	All	7⅝—7⅞
10	German Union Telegraph and Trust	All	7¾—8¼
10	Globe Telegraph and Trust	All	5⅜—5⅝
10	Ditto, 6 per cent Preference	All	10¼—10⅝
10	Great Northern	All	9¼—9¾
25	Indo-European	All	20—21
10	Mediterranean Extension	All	2¾—3¼
10	Ditto, 8 per cent Preference	All	9¾—10¼
10	Panama and South Pacific	2½	..—..
8	Reuter's	All	10—10½
Stock	Submarine	100	190—200
1	Ditto, Scrip	All	1¾—2
10	West India and Panama	All	2—2½
10	Ditto, 10 per cent Preference	All	10¼—10¾
20	Western and Brazilian	All	13¼—13¾
1000 dls.	Western Un. U.S. 7 per cent 1st M.B.	All	106—108
100	Ditto, 6 per cent	All	89—90
10	Hooper's Telegraph Works	All	7—7½
50	India-Rubber and Gutta-Percha	All	20—21
Cert.	Submarine Cables Trust	100	95—97
12	Telegraph Construction	All	21½—22½
100	Ditto, 7 per cent Bonds	All	100—103

The traffic receipts of the Brazilian Submarine Telegraph Company (Limited) for the month of August last amounted to £10,032, as against £9761 for the corresponding month of 1874.

The Eastern Telegraph Company's traffic receipts for the month of August last amounted to £30,005, and for the corresponding month of 1874, to £31,265.

The traffic receipts of the Western and Brazilian Telegraph Company (Limited) telegraphed from Brazil for the four weeks ending the 27th ult., were £8543 4s. 5d.

The traffic receipts of the Anglo-American Telegraph Company for the 24th Aug. were £1260; for the 25th inst., £1350; for the 26th, £1470; for the 27th, £1480; for the 28th, £1340; for the 29th, £400; for the 30th, £1230; for the 31st, £1500; for the 1st Sept., £1560; for the 2nd, £1410; for the 3rd, £1410; for the 4th, £1200; for the 5th, £510; for the 6th, £1150; for the 7th, £1540.

The traffic receipts of the Direct Spanish Telegraph Company (Limited) for the month of August amounted to £1773, against £1282 in the corresponding period of last year.

The traffic receipts of the Great Northern Telegraph Company for the month of August amounted to 385,001f., against £415,383f. last year. The total traffic receipts from the 1st of January to the 31st ult. were 2,794,859f., against 2,902,109f. last year.

PATENTS.

Improvements in galvanic batteries. Edward Tyer, of No. 4, Old Street, Finsbury, Middlesex. February 6, 1875.—No. 449. This invention relates to cells of galvanic batteries, a single cell being a jar or vessel with grooves or lugs in its interior or notches in its sides, into which is slid a perforated slab of non-conducting material to separate the two elements, and compound cells being formed in a box divided by permanent partitions into a number of cells, into each of which is slid a like perforated slab. In some cases the slab is clothed with paper or porous fabric. The chief object of the invention is simplicity of construction in a form which gives facility for cleansing all parts.

Improvements in the application of electro-dynamic machines for obtaining metals from their salts, regenerating galvanic batteries, and obtaining other chemical reactions. William Clark, patent agent, 53, Chancery Lane, Middlesex. (A communication from Dieudonné Francois Lontin, Paris.) February 8, 1875. No. 473.—The invention consists, first, in the utilisation of the whole of the electricity produced by an electro dynamic machine for decomposing metallic salts from which it is desired to obtain the metal. Second. In obtaining most of the metalloids by dynamo-chemical decomposition. Third. In producing organic and other chemical products by like means. Fourth. In regenerating spent galvanic batteries by a current from an electro-dynamic or dynamo-chemical machine.

An improved mode of applying breaks to railway engines and carriages. William Samuel Laycock, manufacturer, Sheffield. February 9, 1875. No. 478.—My invention consists in the use of electricity or magnetism for applying the breaks to railway engines and carriages, or to machinery by which the said breaks are applied.

Improved mode of and means for increasing the adhesion of locomotive wheels on rails. Peter Jensen, Chancery Lane, London. (A communication from Emil Bürgen, Basle.) February 11, 1875. No. 506.—Locomotive driving axle is covered with coils of insulated copper wire, the wheels being the poles of a powerful electro magnet.

*** Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which "The Electrical News and Telegraphic Reporter" is the organ, will always command attention. Literary communications and books for review should be addressed to the Editor; business communications to the Publisher, Boy Court, Ludgate Hill, London, E.C.

THE ELECTRICAL NEWS

AND

TELEGRAPHIC REPORTER.

EDITED BY WILLIAM CROOKES, F.R.S., &c.

TO ELECTRICIANS EVERYWHERE.

Since the day when Electricity was first discovered, until now, its vast importance and its high destinies have grown upon the human mind. Fresh phases of its power, fresh results, new means of obtaining and governing its action, and multiplied ends to which it may be turned, have constantly discovered themselves; till to-day it stands out as one of the grandest subjects presented to the scientific and practical world for investigation and research. Perhaps, however, no other Science or Art has exhibited so extraordinary a concurrence of anomalies. It is at once the most terrible monster and the most humble and obedient servant, its action is at one moment beneficial, at the next destructive; its range is boundless, yet it may be "cabined, cribbed, confined" at ease; it is everywhere present, while its nature is only imperfectly understood; and, to crown all, although it is one of the most important agents in the action and the phenomena of the universe, and increasing knowledge of its applicability to the needs of our race is of the utmost importance, no direct means of ascertaining the thoughts and discoveries of its students, or of bringing them before the scientific and mechanical community, at present exist. Attempts have been made to supply this want, and journals have been started with the professed object in view of making public all that is known or can be learnt of Electricity in all its branches. But they have degenerated into unscientific records of unimportant events, and the purpose for which they were established has been lost sight of. Thus it comes that—while Engineering, Chemistry, and other Applied Sciences have all their representative recognised organs—the Electrician finds himself without any current journal from which he can learn the events which are daily occurring of peculiar interest to himself.

Such a want has now been supplied by the establishment of the Electrical News and Telegraphic Reporter. In its columns will be found the most valuable opinions of eminent Electricians and scientific men all over the world. Articles will be contributed which will be of value not only to those who study Electricity as amateur experimentalists or scientific inquirers, but also to those whose daily life is bound up with the advancement of practical knowledge in all departments of the science, and who as electricians, telegraphists, electrotypers, electroplaters, and chemists have continually to deal with the same marvellous agent of force in different ways. Nor will the doings of foreign societies be ignored as in times gone by, but, in the shape of carefully prepared abstracts, their proceedings will be presented to our readers. Every opportunity will be given for the healthful discussion of the science in all its branches, and a fair unbiassed course will be steered in all questions of dispute.

This, then, is our Programme in brief. More we could promise, but prefer to let the new periodical speak for itself. The subject with which it will deal is of too great importance to need one word of recommendation. Daily experience teaches us that we are as yet on the threshold only of a vast expanse of electrical knowledge. This has to be explored, and as the research gains in strength and intelligence the results will be far beyond all present conception. The feat of girdling the earth in forty minutes will be eclipsed by great deeds yet to be done, and if the establishment of the Electrical News and Telegraphic Reporter conduces to the hastening of this desirable end our object will have been gained, and we shall be fully rewarded.

Boy Court, Ludgate Hill, London, E.C.
July 1st, 1875.

London: Printed and Published by the Proprietor, William Crookes, at the Office, Boy Court, Ludgate Hill, E.C.
September 9, 1875.

THE

ELECTRICAL NEWS

AND

Edited by Wm. Crookes, F.R.S., &c.] TELEGRAPHIC REPORTER. [Registered for Transmission Abroad.

Vol. 1.—No. 12.] Thursday, September 16, 1875. [Price, 4d. Post Free, 4½d.

CONTENTS.

'HE ELECTRICAL NEWS.

VOL. I. NO. 12.

EPORT ON CLAMOND'S THERMO-ELECTRIC BATTERIES.

By the Count TH. DU MONCEL.

HE thermo-electric battery, the principle of which was scovered by Seebeck in 1821, is the most constant source f electricity possible to obtain, since the energy of its urrent depends solely on the difference of temperatures t which the extremities of diverse elements composing it re maintained. The first thermo-electric batteries contructed for industrial purposes were contrived by Marcus, 'armer, and Becquerel, with a combination of metallic lloys. To them, also, we look for the first production of hese batteries in smallest possible size and with maximum f power. The pairing of pure electro-positive and lectro-negative metals, when they are even at the most pposite ends of the scale of electromotive qualities, does ot furnish the most energetic effects: the most energetic ffects are mainly dependent on metallic alloys. Marcus irst made an energetic battery whose electro-negative element was an alloy of antimony, zinc, and bismuth, with an electro-positive element of nickel, copper, and zinc. In mixing these metals proportional to their chemical equivalents he obtained a maximum action. On the other hand, E. Becquerel, from personal researches, used antimony and cadmium for one element, and German silver for the other. From this latter combination very energetic results were obtained, and in that manner the thermo-electric batteries manufactured by Ruhmkorff were constructed. Then Farmer, of Boston, and Clamond, settled the question as to the best arrangement for giving highest temperatures, and for obtaining a great number of elements easily disposed for potential or for quantity as required. To Clamond most of the credit for this little arrangement is due. He at first made his battery of iron and sulphuret of lead, or galena, of little cost; and these he heated by a gas, coke, or petroleum stove. The results were, from the first advantageous; but shortly after it was soon rendered useless from the roasting of the galena, its cracking, and the enormous increased resistance of the couples. Hence the galena was abandoned, and a zinc and antimony alloy used in preference, with iron for the electro-positive element. Undoubtedly by taking copper, nickel, or German silver, a higher electromotive force might be obtained; but experience has shown that when copper or German silver is dissolved in the alloy (on account of the prolonged action of the apparatus) iron is retained. The jointing between the iron and alloy was effected in this wise:—The iron was doubled back, in the shape of, as it were, a hinge, and on that portion the alloy was allowed to run in a state of fusion: when cold the alloy became a fixture around the iron flange. The splitting of the material—which almost always took place in parallel layers, in ordinary alloys, under the influence of alternate heat and cold—is prevented by pouring it into conveniently heated moulds. In these batteries the elements are arranged circularly for potential, so as to form species of crowns insulated from each other by asbestos plates. Their polar ends are connected by means of a commutator attached tangentially to the cylindric surface of the apparatus, and are so disposed as to allow of their being grouped in potential or quantity series, as required.

Austrian Telegraphs.—In 1874 there were forwarded in Cisleithanian Austria 13,792,557, telegrams, being an increase of 1,844,220 on 1873. The total length of line, including private lines in Vienna and suburbs, is 82,718·60 kilometres against 78,837·90 at the end of 1873.

ELECTRIC VOTE-REGISTERS.

THE following system of vote-registering, suggested by Mr. E. A. Jacquin, although totally differing from Messrs. Clérac and Guichenot's method,* possesses considerable merit. It does not, however, record its workings before the eyes of voters as Messrs. Clérac and Guichenot's system does; and partly for this reason it failed to be approved of for the National Assembly.

Two buttons are placed before each Deputy, who registers his vote by simply pressing them down; the nature of his vote being determined by the order in which they are depressed. Each button is an electrical communication with a small apparatus which encloses a supply of balls, and from which one drops whenever its corresponding button is pressed. The white-ball and the blue-ball apparatus are all ranged by themselves, and the balls fall from them into funnels, and thence through ramified pipes into two urns, by the force of gravity. They are all made exactly equal in weight; hence the number of Deputies who have voted is immediately obtained by weighing the urns.

In order to avoid as much as possible calculating the number of balls from the weight of the urn, the weight of each ball can be made 10 grms.—a very convenient size. Then on reading the weight of an urn the number of balls in it is directly proclaimed. Thus an urn weighing 1500 grms. would contain 150 balls. In speaking of the weight of the urn, reference is of course only made to its contents: the weight of the urn itself is previously balanced.

In addition to this, an automatic pointing is effected by each apparatus on small strips of paper introduced into it before the sitting, and the object of this pointing is to indicate the nature of the voting. At the close of the sitting, the pointed or dotted papers are withdrawn, collated side by side in numerical order, and form a complete detailed table of the votings for that sitting.

The battery for each Deputy, consisting of two Leclanché elements, is inclosed in a box bearing the Deputy's number, and the wire starting from the positive pole is in connection with an electro-magnet and thence to a kind of small metallic anvil; the negative pole through another wire is in connection with a small lever placed above the anvil, from which it is held at a very small distance by a spring. The Deputy pressing upon a button, causes this lever to touch the anvil, and so to close the circuit through the electro-magnet.

The remainder of the contrivance, which each button works, is thus described:—

The electro-magnet attracting a lever releases a hinged pan containing the voting ball, and thus allows it to fall into a funnel, whence it is conveyed to the urns. At the same time that the shovel drops, a pin affixed to its bottom causes the dotting upon the paper strip to which we have already drawn attention to be effected.

The recording sheet for each voting is divided into series of three small transversal and two vertical columns. The former may be called for convenience *a*, *b*, and *c*; the latter *d* and *e*.

In explanation, let us assume that voting is about to commence, and that the transversal column *a* is ready to be dotted. Deputy A, let us assume, is voting affirmatively. He presses his left-hand knob, and his sheet is struck in the afirmative vertical column *d*, in *a*. Then every paper is raised automatically, so that *b* transversal column occupies the late position of *a*. Our Deputy then presses down his right-hand knob, which produces a dot in the negative vertical column *e*, in *b*. Should he desire to vote against a measure, the order of pressing down the knobs which we have given must be reversed. In other words—

* ELECTRICAL NEWS, vol. i., p. 13.

Affirmative vote { Left-hand knob. Right-hand knob.

Negative vote { Right-hand knob. Left-hand knob.

A special piece of mechanism provides for the distribution of the balls into the machines. Behind a row of receivers, there is a horizontal axis running in direction at right angles to the lever. This shaft carries an arm, which is placed in the same vertical plane as the tail of the shovel; and its position with regard to this tail is such that, when the shovel has fallen, if half a revolution is given to the shaft, the upper part of the arm in passing forces upon the tail, and raises the shovel above the lever which retains it in position. The pan is now ready to be loaded with a ball.

An axle carries a cog-wheel, which works into a larger wheel. This larger wheel works upon the same shaft as another wheel around whose circumference there are fixed a certain number of compartments, and this revolves inside the drum in suchwise that the extremities of the paddles (to which the sides of the compartments may be likened) graze the inner surface of the drum. The lower portion of the drum, just above the shovel, is pierced with a circular hole, large enough to allow a ball to pass. Through another aperture, in the upper portion of the drum, the balls are passed into the several compartments—care being taken that the lower orifice is closed during the loading process.

Each compartment being filled, a simple mechanical arrangement in adjusting the diameters of the two cog-wheels will cause the pan to be loaded every time a semi-revolution of the arms raises it from its fallen position.

The mechanism by which the instantaneous discharge of the pans of those Deputies who have not voted is accomplished, only remains to be explained. It is comprised of a hard wooden circular table, upon whose upper surface, and parallelly to the circumference, there are hollowed out two adjacent grooves, separated by a narrow strip of wood. In each groove, small copper plates, separated from each other by insulated spaces, are embedded; and the number of them equals that of the instruments. Each metal piece is also so placed that a radius which passes through the middle of one plate in one groove will pass through the middle of another plate in the other groove. Thus the plates may be reckoned as arranged in couples, each of which is in electrical connection by derivation with the same set of apparatus. If then we touch any of these couples with the poles of a battery, we work the apparatus belonging to them.

The table is now turned by a crank movement, and the metal couples pass under an arrangement by which a current is successively passed through them, and the instruments of those who are either absent or have refrained from voting are acted up, their balls are liberated, and two dots are affixed in the c transversal column of the table. The electro-magnets of the instruments of those who have voted are likewise acted upon, but their pans having dropped, they simply move the lever without any other result.

For an engraving, showing more clearly the construction of the apparatus, we refer our readers to the *Journal Télégraphique* for July 25th.

A CAPILLARY ELECTROMETER.

We propose to give an account of the instrument so named, which has lately been devised by M. Gabriel Lippman, and which is interesting both from a theoretical and a practical point of view. A memoir by the author, in which it is described, and the general relations between electric and capillary phenomena are studied, appears in a recent number of the *Annales de Chimie et de Physique.*

The capillary electrometer is constructed on a principle which is thus enunciated:—*The capillary constant at the surface of separation of mercury and dilute sulphuric acid is function of the electric difference which occurs at that surface.*

The name of *capillary constant*, or *superficial tension*, has been given to the coefficient A in Laplace's formula—

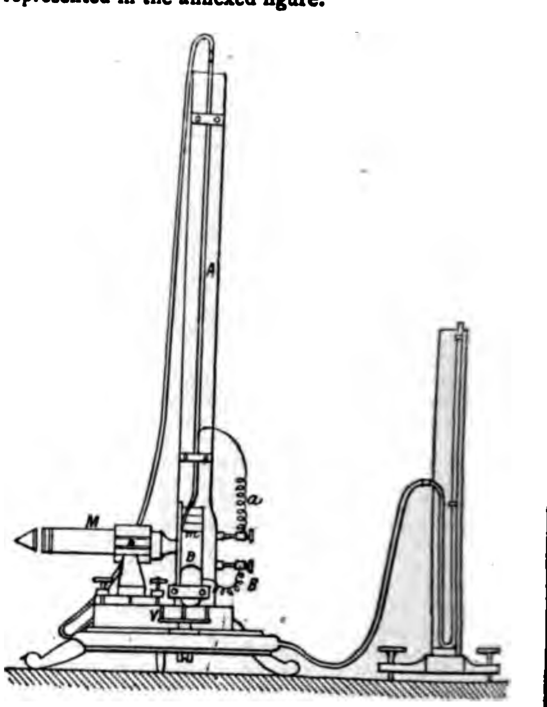
$$p = A\left(\frac{1}{R} + \frac{1}{R'}\right),$$

where p is the normal pressure at any point of the surface, referred to unit of surface; R and R' are the principal radii of curvature at this point. A liquid being in equilibrium, its form is determined when one gives—besides the conditions as to limits—the numerical value of A. Conversely, A is deduced from the form affected by the liquid surface; it is a number given by experiment.

Equilibrium being established, we know that the electric potential has, within the mercury, a uniform value, V; and, similarly, the electric potential has, within the mass of water (or acidulated water), a uniform value, V_0. On either side of the surface of contact the difference of potential is therefore $x = V_0 - V$. It is this difference which M. Lippman calls the *electric difference* at the water-mercury surface.

This being agreed, experiment shows that if the apparatus be so arranged that x has a fixed value x_0, A has a value A_0 exactly determined; that is to say, that the perturbations observed with the ordinary arrangement are no longer produced. If x be maintained at a new fixed value x_1, A takes a new value A_1, a value determined exactly and without perturbations. Thus to each value of x corresponds a value of A, and one only.

In the capillary electrometer the variations of a meniscus of mercury, with variation of the electric difference, are observed through a microscope. The apparatus is represented in the annexed figure.



An ordinary glass tube, A, about 1 metre in height and 7 m.m. in diameter, open at both ends, is fixed by supports in a vertical position. The lower part has been drawn out in a lump, so that the interior diameter of the finest part is reduced to a few thousandths of a m.m. This *capillary point* dips in dilute sulphuric acid (1/6th of the acid in volume) contained in a reaction-tube, B, which is

fixed below the longer tube. At the bottom of B is a mass of mercury.

Into the tube A is poured a column of mercury sufficiently high for the mercury to penetrate, by its own pressure, into the capillary point (750 m.m. for example). The masses of mercury in A and B are put in communication with two insulated electric binding-screws, by means of the platinum wires α and β, soldered to the screws. The wire β does not touch the acid of the tube B.

The capillary point is brought into application to the side of the tube B, so as to be in the field of the microscope M, which is fixed horizontally in front of this tube, and which magnifies 250 times. This microscope is supported on three screws: the point of one of these turns in a small conical cavity; that of the second moves in a straight groove; that of the third is applied to a horizontal plane; a strong spiral spring tends to hold the tripod on the plate. The microscope is furnished with a reticule, or—better—with an ocular micrometer traced on glass. To obtain a distinct image the axis of the microscope should be as nearly as possible perpendicular to the side of the tube B.

For compressing the air above the mercury in A, the apparatus is fitted with a small screw press, worked by means of the handle V: under this press is a longish caoutchouc bag, with thick sides, containing air. The bag communicates, on the one hand, with the top of the tube A, and on the other with a free air manometer, placed near the apparatus.

After filling the apparatus, one expels the bubble of air which remains in the capillary point, by compressing the air above A, so as even to force out a little of the mercury. During this operation one puts α and β in metallic communication, and atmospheric pressure is next restored over the mercury A. The meniscus *m*, which terminates the mercury in the capillary point, then assumes a position of determinate equilibrium, which we may call the zero of the apparatus. The microscope is displaced so as to bring the zero of its micrometer to be tangent to the image of the meniscus; and it does not leave this position. The apparatus is now ready. (It is well to remark that the zero does not become absolutely fixed till some time after filling the apparatus; it descends very slowly for two or three days.)

The capillary electrometer (M. Lippman says) has all the properties of a very sensitive electrometer. It may prove very serviceable in measuring electromotive forces.

To measure the electromotive force of a battery element, *e.g.*, the negative pole is connected with α, the positive with β. The handle V is turned till the meniscus is brought back to zero, and the pressure is read off on the manometer.

The measurement is then terminated: it remains to convert to electromotive force the pressure observed. For this purpose one may use a table prepared beforehand, or a curve obtained by making the electromotive forces abscissæ and the compensating pressures ordinates. The formation of such a table, giving the electromotive forces opposite the compensating pressures which correspond to them, constitutes an empiric graduation of the electrometer. As the author shows, all capillary electrometers are comparable for a given concentration of acid. Thus, suppose we had an apparatus in which the height of the column A was 900 m.m. instead of 750; its graduation would be obtained by multiplying the compensating pressures inscribed on the table by the ratio $\frac{900}{750}$. However simple this calculation of reduction, it is short, and more direct to re-make the graduation oneself, if one possesses a well-constructed box of resistances.

M. Lippman gives several numerical examples of the use of his electrometer—measurement of electromotive force of a Leclanché element, of a Daniell element charged with acid, of an element of amalgamated sulphate of zinc with ordinary zinc. To cite the first:—The carbon pole of a Leclanché communicating with the upper pole of a Daniell, the zinc of the Daniell is put in communication with β, the zinc of the Leclanché with α. The mercury moves out of the field. One turns the handle V till the mercury is brought back to zero; the manometer marks 270·5 m.m. of mercury. The electromotive force inscribed opposite this number in the table is $e = 0{\cdot}450$: hence 1 Leclanché = 1·450 Daniell.

ON THE THEORY OF CONSTRUCTION OF ELECTRIC FUSES.*

THE name *induction fuse*, given to fuses that are inflamed by a current from an induction apparatus, seems to have been applied prematurely. Considering that the currents produced, whether by discharges or by chemical actions, are ruled by the same laws, and vary only in their effects, we think the name of *tension fuse* may be much more rationally applied to fuses in which the platinum wire is replaced by a powder, whose conductivity may vary within certain limits, but which has a great resistance, capable of being overcome only by a current of high tension. To distinguish, however, the fuses, which are only inflamed by ordinary induction apparatus, and those which may be exploded either thus or by a battery current (40 to 150 piles in tension) we shall designate the former *induction fuses*, and the latter by the more general name of *tension fuses*. The induction fuse, of which that of Ebner is a type, is more easy of construction than these latter. For, in tension fuses, the conductivity, the compression (*tassement*), and the separation of the wires play a very important part, and if the conditions in these respects be not strictly fulfilled, the sensitiveness to inflammation decreases till the number of piles required puts such fuses beyond possibility of use.

In what follows we have assimilated the currents of static and dynamic electricity . . . We assume that the electric spark is only a particular case of the electricity of batteries of high tension.

We have observed that:—

I. With the same conducting powder, compression of it, and separation of the wires, the greater the section of wire the more is the galvanometer deflected. The cylinder of powder between the two sections of wires may be compared to a resistant conductor the conductivity of which increases with the section. We know that the conductivity of a wire is in direct ratio of its section.

We have determined empirically a constant diameter of wire, corresponding to a given sensitiveness of inflammation (with the same compression), verified by the deflection of the galvanometer. It may be easily conceived, that if we change the diameter of the wire, all other conditions remaining the same, the fuse will no longer have the same resistance, and to obtain the previous effect it will be necessary to alter the conductivity, and consequently the compression, with the result of presenting a greater or less number of conducting molecules to the action of the current.

II. If while diminishing the diameter of the wires we increase the compression so as to have the same deflection in the galvanometer, the fuse will be less sensitive to inflammation. In fact, suppose the powder cylinder between the sections of wires to represent a bundle of platinum wires, very fine, and therefore very resistant; to compress the powder is to bring close together the molecules forming it, or, in one comparison, to diminish the distance separating the platinum wires so as at length to form a single wire, of section equal to the sum of the partial sections. The resistance of the platinum wire to the current will not have changed, but as the heating of a wire traversed by an electric current varies in inverse proportion to the fourth power of the wire, it follows

* Abstract of portion of memoir by MM. Champion, Pellet, and Grenier, in *Annales de Chimie et de Physique*.

that the heat developed in the fine wires by the inflaming current will be much less, and consequently the sensitiveness to explosion will be altered. This law is the same whether the heating be produced by a discharge or by the battery current.

III. With the same section of wire and the same compression, if the separation of the wires be increased, the resistance becomes greater in proportion to the elongation of the cylinder of powder, and so there is less sensitiveness to inflammation: if we compress more, so as to obtain the same deflection, the case is one belonging to paragraph II.

According to these principles, the wires should be brought near together, and should have a small diameter; but here there are several considerations important in practice.

If a very small diameter be used, the cylinder of powder presents too much resistance, and consequently is not heated; (it is the same with platinum wires). If, on the other hand, we increase the diameter beyond certain limits, the current of tension will become insufficient as quantity for batteries with weak surface, or induction apparatus of limited volume.

As to the interval of the wires, which should be absolutely uniform, it does not seem possible, practically, to reduce it below $\frac{1}{10}$ of a millimetre. Moreover, as the compression of the powder cannot be rigorously the same in all the parts of the section, there occurs a sort of compensation which one cannot obtain with a very small section. It should be added, that in approximating the wires we diminish the volume of powder, and that the repeated passage of the test-current, which always modifies the constitution of the inflammable matter, more or less according to its composition and the intensity of the current, rapidly diminishes the sensitiveness.

The above facts can be appreciated only on condition of employing electric apparatus (piles or induction apparatus) furnishing but a small quantity of electricity, and using powder suitably prepared. In this respect it may be remarked, that with inflammable powders equally conductive but of different compositions (all other things equal), the same deflection of the galvanometer does not furnish any indication with regard to sensitiveness, this depending only on the nature of the elements which constitute the powder.

The differences mentioned *apropos* of section and separation of the wires are not sensible with powerful induction apparatus, owing to the quantity of electricity and the high tension of the current. It is thus that in such cases we may use indifferently even non-conducting powders, and put out of consideration the principles we have established as to maximum of sensitiveness to inflammation; and it is the same with fuses of platinum wire, when there is excess of quantity and of tension.

The *coup de poing* seems to hold the middle place between powerful apparatus, such as the Ruhmkorff coil and the small induction-instrument, such as those constructed by M. Gaiffe for medical purposes. Still, in practiced hands one may readily perceive the difference of sensitiveness of fuses by means of the *coup de poing*; but the tension of the current furnished is so considerable that one cannot deduce from the results obtained any precise measure, and that the apparent limits of sensitiveness cannot be applied to piles arranged in tension. In the conditions in which we are placed, the maximum sensitiveness of the battery appears to correspond to the same sensitiveness in induction apparatus; but it would be no longer the same if the number of elements were diminished. (We used 40 Leclanché elements of small size).

In comparing the powder cylinder between the wires to a bundle of fine resistant platinum wires we have not taken into account the loss of electricity through contact with the equally conducting powder which surrounds the cylinder in the fuse; but it is known that the greatest intensity of current is manifested between the points. By suitably retarding the instantaneous discharge one may transform it into a current which has a different action.

The sensitiveness of a powder to the electric action may be inverse to its sensitiveness to explosion under the blow of a hammer. First. If we mix equal parts of fulminate of mercury and protosulphuret of copper and pound it for some time in alcohol, we obtain a powder which is very sensitive to the induction current, and yet the addition of the sulphuret diminishes much the sensitiveness to a blow. Second. If we make a powder of the type of Ebner's, with chlorate of potash 51, sulphuret of antimony 50, retort carbon 25 to 30, we obtain a product which is sensitive to the induced current, but the sensitiveness of which to a blow diminishes proportionally to the quantity of charcoal.

MM, Rousset and Delambre have shown that if, to a mixture of red phosphorus and charcoal, be added small quantities of chlorate of potash, the fuse becomes sensitive to powerful apparatus; and that if the proportion of chlorate of potash be increased so that the mixture becomes more sensitive to a blow, the fuse charged with this mixture becomes sensible to less powerful apparatus, and at length acquires an extreme sensitiveness.

For a powder to be sensitive to the electric current, it is necessary that its composition be such that it presents a certain tendency to dissociation, and consequently, on varying the proportions of such or such a body which enters into its composition, the sensitiveness will be increased or diminished on the case cited: there is simply coincidence between the proportions necessary to sensitiveness, to blows, and to the electric current; but one cannot deduce a general fact.

Given a suitable explosive mixture, but without any conducting body, its facility of inflammation under the electric current will increase proportionally to the quantity of an inert conducting body which one adds to it (plumbago, charcoal, &c.) up to a certain limit, beyond which the sensitiveness will diminish, owing to the too great conductivity of the mixture; and the conducting body will have the effect of weakening, proportionally, the sensitiveness to blows; it will, in this case, play the part of silicon, the addition of which to nitro-glycerine *e.g.*, as also to a host of other explosive substances derived from polyatomic alcohols (nitroglycol, nitromannite, &c.), diminishes the facility of inflammation by blows.

We believe we may conclude from the foregoing that the inflammation of induction fuses cannot be attributed to the shock produced by the spark.

In studying the sensitiveness of fuses, the use of apparatus giving a series of induced currents furnishes uncertain results unless the time of action, accurately determined, be taken into account.

The principal inconvenience of induction fuses is their requiring the employment of conductors completely insulated, which is not the case with platinum-wire fuses; but this inconvenience mostly disappears on substituting caoutchouc for gutta-percha as insulating layer, the causes of deterioration not having the same effect on caoutchouc, owing to its elasticity and resistance. The losses of electricity can thus, only occur by joints, which it is always easy to insulate, either with gutta-percha, or, better, with a band of vulcanised caoutchouc, well compacted and impregnated with varnish. Another inconvenience of induction fuses results from formation of a current, even in an insulated circuit, placed parallel by a few decimetres from a circuit in communication with an induction apparatus. One observes in the second circuit the formation of an induced current which may inflame a fuse.

M. Gaiffe has lately made some experiments on this subject, and has determined some of the conditions in which this fact occurs. In military mining operations, then, the conductors should be completely insulated, and separated from each other as much as possible by non-conducting bodies.

The employment of tension fuses seems capable of obviating this inconvenience, the electric current necessary to their explosion having but an excessively weak tension proportionally to that of induction currents.

Riess has observed that a wire near that which allows the discharge to pass may retard the latter when it is a less good conductor. For the effect to be sensible the discharge wire must be wound in a spiral, as also the other, so that considerable lengths of the wires are in presence of each other. The two ends of the wire independent of the battery must also be joined so as to form a closed circuit. There is evidently an induction effect in the circuit the electricity of which reacts on that which passes in the discharge wire. The retardation is more pronounced the less conducting the induced wire.

It is evident, *a priori*, that we may prepare powders for induction, and tension fuses with a great quantity of substances, provided the mixture has a suitable conducting power. In this respect we believe we can rectify, *en passant*, some errors about certain bodies such as picrate of potash and nitro-glycerine.

Picrate of potash, even with chlorate of potash added, which much increases its facility of explosion, does not undergo any alteration in presence of ozone contained in the air; and they are mistaken who have supposed accidents, through explosion of the picrate, to have been produced by this cause; besides, no experimental fact can confirm this opinion.

As to pure and perfectly neutral nitro-glycerine, its fixity cannot be doubted since the labours of Nobel. This engineer has kept nitro-glycerine for more than ten years without observing any alteration, and our personal experiments on nitro-glycerine subjected to various temperatures fully confirm this fact. Certain spontaneous alterations of dynamite, sometimes remarked, have arisen from an incomplete neutralisation of the nitro-glycerine in consequence of defective manufacture.

THE POSTAL TELEGRAPHS.

"CAREFUL and patient consideration" is leading the Press to take a more hopeful view of the present condition of the postal telegraphs. In an article occupying four and a half columns the *Times* expresses the opinion that the remarkable way in which the telegraph revenue has exceeded, year after year, the most sanguine expectations formed concerning it, is far more satisfactory than the increase in the expenditure is discouraging. Some of the views we have ventured to express are, we are glad to find, held by the writer of the article. The Post-Office, we read, should not be governed by the purely commercial considerations which guided the policy of the Companies. The object ought to be—and, so far as we know, it has been—to make the system national, efficient, and popular in the first place, and to make it profitable afterwards, if that should be attainable. Expressing the belief that the system may be made profitable, the writer proceeds to the consideration of the various proposals contained in the Report of the Committee. Referring to the closing of non-paying offices, he writes:—"These offices are, of course, all of the smallest class, and the entire loss sustained by keeping them open must be a small item in the total expense of the Service. The cost of establishing those offices has already been incurred, and to disestablish them would entail further expense. The labour involved in putting up the wires is gone, and could not be recovered by the act of taking them down again, while the material recovered would, at the best, be 'old stores,' depreciated in value by the very act of taking down. But, in many cases, these non-paying offices must, we imagine, occupy positions in the middle of wires which have paying offices at either end, so that the closing of the intermediate offices would not free the wire in the sense intended by the Committee. Further, we know that practically one message gives rise to another, and it is a serious consideration how far the closing of one office might have the effect of bringing some other office within the non-paying limit. Then, too, it must be considered how far the loss of his telegraph emoluments, small as they are, would give a village postmaster, not a claim perhaps, but certainly a cue for demanding higher pay for his ordinary postal work. The expenditure of the Post-Office proper must, in fact, have been kept down by the addition of the telegraph emoluments to the then existing salaries—a fact which might fairly have been kept in view in considering the estimates of telegraph revenue and expenditure put forward by the Committee. There must be many post-offices which do not pay so far as the number of letters is concerned, but no one has had the temerity to propose that they should be closed forthwith. Viewing the Service in both cases as national, the fact of an office not paying affords in one sense the best reason for keeping it open, as otherwise isolated districts would be cut off from communication with the outer world. Thus the Post-Office has been put to great expense in the maintenance of its cable communications, but how would the 'non-paying' principle act if applied to such cases as the Isle of Man, the Channel Islands, or even to Ireland itself? The Committee states it 'has been informed' that there are 373 telegraph offices in London alone, 'many of them at very short distances apart,' and it practically proposes a wholesale reduction in those offices. What grounds exist for this proposal may be seen on turning to the table given in the Report, from which we learn that last year there were only seven of these offices that did not pay their expenses. The Committee itself has furnished us with the best argument against its own proposal in the fact that the number of non-paying offices is steadily decreasing."

Calling in question the practicability of the proposal to transfer the duties of the postal surveyors to the divisional engineers, and of the proposal to place the telegraph system in charge of the Royal Engineers, the writer passes on to consider the proposal that the railway companies should maintain all the telegraphs: seeing, however, that the public is interested in both classes of telegraphs, it appears more appropriate that the control of both should be in the hands of the public department rather than in those of the private companies.

With regard to "Service instructions," which are stated to average 14 words per message, it is found that many of these words consist of single letters, and so far as time occupied in signalling is concerned they do not represent more than six or seven *average* words. "The first consists of a single letter, and informs the clerk who is to receive the message whether he is to write it in duplicate, for delivery to the public, or on a single sheet, for transmission by wire beyond his own office. Clearly such a signal as this cannot be dispensed with. The second signal—composed, on an average, of two letters—indicates the hour and minute at which the message is given in by the sender, and, as the Act of Parliament requires that all messages should be sent in the strict order of handing in, this signal also appears indispensable. So with the third signal, consisting usually of two figures, and denoting the number of words in the message, which is signalled for the protection of the public. The words 'from' and 'to,' which appear on the telegraph forms, are really part of the message; but it is understood that the reference of the Committee to certain modifications in contemplation by the Post-Office points, among other things, to the abolition of the word 'from.'"

It is evident that any economy in this direction is of the smallest possible dimensions, and cannot effect the great reform in the cost of the telegraph service which some have predicted.

The question of altering the tariff is then entered into at considerable length. "If it be true," says the writer, "that there is a deficit of a quarter of a million on the Telegraph Service, the public must not forget, before con-

senting to any alteration in the tariff for messages, that it is saving at the present moment on the 20 millions of telegrams forwarded annually four times the amount of the deficit—namely, one million sterling. The average cost of a telegram six years ago was 2s. 2d.; it is now 1s. 2d.; and this suggests a view in regard to the percentage of expenditure which the Committee has completely overlooked. The Companies, as we have seen, were spending 60 per cent on working costs, and this is contrasted with the alleged expenditure of 96 per cent by the Telegraph Department. Accepting for the time the latter figure (though we believe it to be exaggerated), we have to contrast 60 per cent on 2s. 2d. against 96 per cent on 1s. 2d., and if this be worked out to the proper fraction it will be found that the Government expenditure per message is really much less than the vaunted economy of the Companies.

"The Committee submits two, or we should rather call them three, alternative proposals. The penny per word system may be dismissed in a sentence, seeing it would raise the price of an average telegram from 1s. to 2s. 5d., and would (assuming the same number of messages to be sent) produce a revenue quite out of proportion to the necessities of the Department. The only really feasible proposition of the Committee is that of charging 6d. for ten words, inclusive of addresses, which, assuming that the messages extended to the same length as at present, would raise the average to 1s. 6d. But it cannot be doubted for a moment that a vast number of messages would pass under the *minimum* rate, and upon every one of these it is obvious that there would be a direct loss of 50 per cent. As the messages of this class increased, the Telegraph Department would find itself in the position of having to deal with two messages as regards the consumption of forms, the wages of messengers for delivery, the 'Service' signalling, &c., while it would only draw the same revenue as it does from one message at present.

"The Committee seems to favour what is designated the 'word system of charging messages'—though we may here remark that all systems are 'word systems.' A 'word system'—that is, a one word system—may be practicable with a high *minimum* charge, as in the case of the Atlantic Cables. But the case is different where messages have to be dealt with in thousands, and at such a charge as a halfpenny per word. It appears to us that the moment the present system of uniformity is departed from endless complications must arise, leading to the employment of more clerks to count and charge the messages, more labour to the local postmaster in bringing the charges to account, and greatly more labour at headquarters in checking and auditing the accounts.

"While advocating the principle of uniformity we think there is within well-defined limits a direction to which it might be departed from with advantage to the public and benefit to the revenue—viz., the introduction of a system of local telegrams in London and other large towns and districts at a uniform rate of 6d., applied in the same way as the shilling rate for the United Kingdom now applies. We gather from the report of the Committee that the main source of future cost to the Telegraph Department will arise from pressure on the great trunk lines, on which, when the wires become overloaded with work, the erection of new wires will entail an expenditure that will not be immediately recouped by the traffic. But there is a branch of the Postal Telegraph system which is differently situated—viz., the local wires which serve as 'feeders' to the greater lines. Many of these must be practically undeveloped as yet, and the creation of a traffic upon them would result in an immediate increase of revenue, without any corresponding increase of expenditure. The Committee, alluding to the extensive system existing in the Metropolis, brings out the fact that there are numerous offices at which a telegraph clerk must be kept, whether fully employed or not, and also that at the central offices clerks must be in waiting to receive messages from these branch offices, whether there are any to come or not. Clearly, therefore, in very many cases, the addition of this cheap local traffic would simply mean the filling up of wires and clerk's time not now fully employed, and without adding a penny to the cost of either. The price of messages within the Metropolitan area was nominally raised by the introduction of the Post Office uniform shilling rate, and even under this drawback the number of messages has, we understand, increased enormously between one part of London and another. What, then, might not be expected under an arrangement which immediately reduced the price by one-half, while maintaining the completeness and efficiency of the present system? The messages created by such additional facilities would be mostly of a social and domestic character, and would familiarise the public more and more with the use of the telegraph. The introduction of such a system could hardly fail to promote telegraphy throughout the country, and it would pave the way for the advent of a universal sixpenny rate, which sooner or later must be witnessed in this country."

This exhaustive article ends by considering the tariff for Press messages. The existing arrangements is according to the Committee a "fruitful source of loss" to the Post Office, but the amount of the loss nor the extra charge required to remove that loss is not given. "It was stated recently that whereas the telegraph companies delivered annually some 2,000,000 words of news for the Press, the Post Office is at the present moment delivering annually 220,000,000 words. This is partly composed of messages sent to newspapers on their own behalf, and charged at the rate of 75 words for 1s. before 6 p.m., and the same rate for 100 words after 6 p.m.; and partly of messages sent by the News Associations under the same initial rates, but deliverable at any number of addresses at a cost of 2d. per 75 or 100 words for each address beyond the first. We should have been glad to know whether a loss is sustained by the transmission of both classes of messages, but this information is not given. The Committee practically contents itself with saying that under its proposal for increasing the rate for ordinary telegrams by 150 per cent., some 'concession to the Press' would have to be made. For ourselves, we ask for no 'concession' either from the Committee or from the Post Office, and we much mistake the spirit of our contemporaries if they are not of the same mind. The privileges enjoyed by the Press were deliberately granted by Parliament, and the Blue Books published at the time show what weight the interests of the Press had in the eyes of the Parliamentary Committee which took evidence on the question. Here we may refer for a moment to the system of Press telegraphy as it existed six years ago. The telegraph companies, we are free to confess, supplied news to the Press at a moderate price, for they too were guilty of the 'commercial unsoundness' of carrying news messages at a much lower rate than ordinary messages. As regards the Provincial Press, the companies not only carried the news, but purveyed it; hence they supplied it as it suited themselves, both as regards time, quantity, and character. The tyranny of their system was well illustrated by the evidence of a provincial newspaper proprietor, who stated before the Parliamentary Committee on the Telegraphs Bill that the company had threatened to cut him off from the supply of news altogether because he had ventured to criticise unfavourably some of the details of the service. The Post Office simply carries the news. The question then which presents itself is, to what extent the nation is prepared to go back to the system of protection which formerly obtained. Probably it might be found on inquiry that some modification of the extra address rates should be introduced, or that certain classes of news—sporting news, for example—should be regarded as a luxury, and charged for at a higher rate. But of this we feel sure, that when the subject comes up for discussion in Parliament, the dissemination of Parliamentary

and general intelligence will be viewed as a national service, not to be measured solely by the commercial considerations urged in the report of this Committee."

DISMISSAL OF GOVERNMENT TELEGRAPHISTS.

GOVERNMENT, like men, are beginning to learn the art of perpetrating a wrong gradually. What in the time of Liberal ascendancy would have been denounced as revolutionary audacity is, when brought under the Tory sliding-scale, complacently glossed over, if not excused. Of this, one important branch of the public service is just now furnishing an apt illustration. Terrible commotion was excited in the Telegraph Department of the Post Office by a Treasury mandate—issued, singularly enough, just too late for a protest to be made in Parliament against it—enjoining all those operators not actually in the Telegraph Companies' service, who were taken on by the Post Office in a critical emergency when the Government acquired the telegraphs, to submit to an examination by the Civil Service Commissioners. Such was the indignation aroused among the several hundred telegraphists who, after having for years been recognised as permanent Government *employés*, and not long ago been included in a new "classification list," that it would be hazardous to state what would have happened had this mandate been promptly enforced in its entirety. Remonstrance from a high authority at the Post Office, though ineffectual to stop the flagrant wrong, had a certain weight with the Treasury. The recalcitrant telegraphists, instead of being assailed *en masse*, are being subdued in defile. Little batches are being quietly summoned before the Commissioners; and if they are unlearned in the Eleusinian mysteries, the philosophy of Pythagoras, or unable to define the limits of the zodiac, or attain whatever standard of proficiency may have been prescribed by the Commissioners, they are to be sent to the "right about," and be superseded by others, who, perhaps, cannot distinguish between a Morse and a Wheatstone. Those who agree with the victims as to the harshness of the proceeding, however, may be surprised to hear that it is not in mythology or other antiquated lore, but in plain English geography, that the men are most at fault; for an acquaintance with *Bradshaw* is certainly essential to those who are entrusted with the vital missives which hourly flash through the telegraph wires. Putting aside all question of the merits or demerits of competitive examinations for public appointments—for the case of these old telegraphists is quite exceptional—the man who was a competent operator five years ago is hardly likely now to be inferior to a fledgling fresh from the "crammer;" and ill-natured Radicals may, to say the least, think it a little ungenerous for a Government that rode into power upon a wave of discontent in the Civil Service now to out-Herod Herod by resorting to "weeding out" by a system the most obnoxious of all in the Civil Service—"plucking."—*The World*.

NOTES.

The Central American Telegraph Company (Limited) announce that the cable between Para and Demerara, touching at Cayenne, is now open for public messages, thereby giving direct communication between North and South America.

Quadruplex telegraphy has very recently been accomplished on the Madras Railway Telegraph. The system which Mr. G. K. Winter, the telegraph engineer, invented in March last proved perfectly successful on 80 miles of line, and its extension to lines of greater length is simply a question of additional condensers and battery power. The principle of sending two messages simultaneously in the same direction, on which this quadruple system depends, was successfully worked between Salem and Madras on April 16th last, but unfortunately other duties prevented Mr. Winter carrying out the duplexing of this principle until very recently. His exertions have now been crowned with triumphant success.

Direct communication has been effected between Continental Italy and the Island of Sardinia, by means of the new submarine cable laid between Orbetello and Terranova. The nucleus of the cable consists of seven copper wires, covered with three layers of gutta-percha, alternating with three layers of Chatterton's composition. The copper weighs 107 lbs. and the gutta-percha 140 lbs. per nautical mile. The length of the main portion of the cable is 106·016 nautical miles (= 193·342 kilometres), besides two portions, of 3 and 7 miles respectively, running along the coast.

The electric light has recently been applied for lighting the mills belonging to Messrs. Heilmann, Ducommun, and Steinlein, in Mülhausen. In a separate room four magneto-electric machines are placed, which feed four suitably located lamps constructed on the Serrin principle. The dimensions of the room so lighted are 60 metres (= 196·8 feet) by 30 metres (= 98·4 feet). Each lamp gives a light equal to about 100 Carcel lamps. Each magneto-electric machine requires about 50 kilogrammetre (360·8 foot-pound) motive power. The cost of the four lamps, exclusive of the maintenance of the motive power, averages about 10d. per hour. The magneto-electric machines have each cost 1500 francs (= £60), the whole arrangement amounting to 8000 francs, or £320.

A singular occurrence on the Stock Reporting Telegraph lines, at Montreal, Canada, is reported by the New York *Telegrapher*:—The galvanometer used would vary so much that it was necessary to take out or put in at times 500 ohms resistance to steady it. There is about 3000 rheostat resistance in the line. A peculiar smell was also observed, which became so strong that the operator could scarcely stand it. Upon an examination being made under the transmitting table the remains of a *mouse*, which had got in between the two battery thumb-screws, was discovered burned to a cinder. It is rather singular that during the whole time only one or two of the instruments were seriously affected. It is not known how long the mouse was thus caught, but it must have been for some time to have been so thoroughly cremated by the battery current.

There is no probability of the negotiations for the consolidation of the Atlantic and Pacific Telegraph Company with the Western Union, to which we referred last week, being brought to a practical issue. Mr. Jay Gould, on behalf of the Atlantic and Pacific Company, has since withdrawn all propositions for negotiation.

NOTICES OF BOOKS.

A Treatise on the Origin, Progress, Prevention, and Cure of Dry Rot in Timber; with remarks on the means of Preserving Wood from Destruction by Sea-Worms, Beetles, Ants, &c. By Thomas Allen Britton. London: E. and F. N. Spon. 1875. Crown 8vo, cloth; 320 pages, and 10 illustrations.

In the title of this work the author does not fully describe its scope. It would seem to be more correct to substitute *decay* for *dry rot* in the title page, because the greater portion of the work is upon rot produced by moisture, and the vegetable—the fungus—which M. Bourseul in a recent number of this journal stated to be generally its special attendant.

M. Bourseul declares dry rot to be the result of the dominant action of air; wet rot, the result of the dominant action of water: in other words, a chemical change of the timber's substance. The latter may exist alone, but more generally is accompanied by a fungus, by which the destructive effects are largely multiplied. It is this form of decay which telegraph engineers find so difficult to prevent.

Our author's nomenclature of dry rot, however, as will be seen from the following quotation, embraces an area including both the above kinds of rot. He says: "The opinion generally received has drawn a line of discrimination between the decay accompanied by a vegetable spreading on the surface of the timber and that which is effected by an animal existing within it, which decay is frequently denominated the worm in timber; but as each is equally entitled to the dreaded appellation, they might be more justly distinguished as the animal and vegetable rot. Dry rot in timber derives its name *from the effect produced and not from the cause:* it is so called in opposition to the wet rot, which is properly denominated, as this exists only in damp situations, and is applied to the decomposition of timber containing sap and exposed to moisture. *Dry rot differs from wet rot in this respect that the former takes place only when the wood is dead, whereas the latter may begin when the tree is standing.*" The italics are our own, and show that notwithstanding a restricted title, the treatise if an exhaustive work must refer to that special decay so injurious to telegraph poles.

Some idea may be formed how difficult it is to prevent the fructification of fungi on timber from the statement that "some naturalists have insisted upon their spontaneous production, whilst others maintain the seed is taken up and supported in the air until a soil proper for its nourishment is presented;" and again, "if rot shows itself in a damp closet or pantry, the inside of the china lying there will be coated with a mould, or a fine powder like brickdust, no other than unaccountable myriads of the reproductive spores or seeds of the fungus. . . . If these be allowed to fall on wet flannel, damp blotting-paper, or wet wood, they immediately germinate and proceed to reproduce the parent fungus. The red skin of the spores crack at both ends, and fine mycelial filaments are sent out: this is the "mould," spawn, or *mycelium*."

Is it to be wondered, therefore, that, notwithstanding the greatest care, fungi are sure to attack our poles and posts whenever favourable conditions arise—that is when the poles are situated in damp and wet positions exposed to alternate heat and cold? These favourable conditions immediately produce the timber's disintegration; it ferments, and immediately the almost omnipresent spores attack the fermenting wood with destructive energy. Nor can we be surprised at the little benefit often attending the exposure of undersoil to the atmosphere when fungi spores may be thrown off into the air from neighbouring fungi, and carried into the upturned soil by the next heavy shower.

A great many examples are given to prove that timber will be preserved for a long period if it be *always kept dry* or *always wet*, and that there exists a point between the two when "rot" takes place most rapidly. "Decay of timber will," however, "arise from the effects of continued dryness or continued wetness, under certain conditions." What these conditions are Mr. Britton unfortunately does not tell us. It is likewise mentioned on the authority of Mr. McWilliam, that if the temperature be very low or very high, the effects are the same with respect to the growth of fungi. At 80° rot proceeds rapidly; at 90° its progress is more slow; at 100° it is slower still, and from 110° to 120° it will in general be arrested. It will proceed fast at 50°; it may be generated at 40°; its progress will be slow at 36°; and is arrested at 32°; yet it will return if the temperature is raised to 50.

Regarding the description of the different kinds of fungi—"In the earth they are fibrous and perfectly white, ramifying in the form of roots; passing through substances from the external surface, they sometimes differ from that form. Here it separates into innumerable small branches." Proceeding from the slime in the fissures of the earth, they are generally very ramous, having round fibres shooting in every direction. If they arise from the roots of trees, their first appearance is something like hoar-frost; but they soon assume the mushroom shape.

On the other hand, that "protruded from a very damp situation is fibrous, of moderate thickness, and feels fleshy. From the spot whence it arises it extends equally around, wholly covering the area of a circle. . . . Its surface is pursed, and of various colours; the centre is of a dusky brown, mixed with green, graduated into a red, which degenerates into a yellow, and terminates in white." Then comes the *Merulius Lachrymans* so well known to telegraph engineers. It is "large, fleshy, but spongy, moist, ferruginous yellow, arachnoid and velvety beneath; margin tomatose, white; folds ample, porous, and gyroso-dentate."

Another formidable fungus is the *Polyporus hybridus*: white, mycelium thick, forming a dense membrane, or creeping branched strings; hymenium breaking up into ariæ; pores long, slender, minute."

Such is a description of these slender but destructive vegetables. Though so fragile, we have it on very good authority that they have, by growing betwixt the timbers of a man-of-war forced the plank from the ship's side half an inch. Another instance of the lifting power of fungi was observed at Basingstoke not many months after the town had been paved. The stones in one spot were lifted by the growth of large toadstools beneath them. One of the stones measured 22 inches by 21 inches, and weighed 83lbs., and the resistance afforded by the mortar which held it in its place would doubtless be a greater obstacle than the weight.

Canadian yellow pine is more subject to rot than Baltic or Canadian red wood. *Turpentine is a preventive against rot*, and Canadian timber is sometimes largely impregnated with it. It appears that timber when landed in this country, either from Canada, Norway, or Sweden, is frequently found to be largely impregnated with fungi; hence it is not surprising, considering the spreading nature of the plant, the timber used should readily rot.

An important question regarding the preservation of timber is how to destroy or keep away the fungus. This does not, we regret to say, call forth any recommendations from Mr. Britton, who indeed scarcely touches upon the question.

We are informed that "the confinement of timber under most circumstances is attended with the worst results; yet a partial ventilation tends to fan the flame of decay." Also, "if dry air be properly admitted, in a quantity adequate to absorb the moisture, it will destroy the fungus; but care should be taken lest the air should be conveyed into other parts of the building; for, after disengaging itself from the fungus over which it has passed, it carries with it innumerable seeds of the disease, and destroys everything which offers a bar to its pro-

gress." For this reason air is often admitted into buildings without ultimate success; on the contrary, the fungi have frequently spread after the admission of air.

Mr. Britton apparently attaches great importance to the felling of trees, as upon this depends, in some measure, the durability of the timber. The results of a series of experiments made in Germany show that December-cut wood allows no water to pass through it longitudinally; January-cut wood passed in 48 hours a few drops; February-cut wood let two quarts of water through in 48 hours; March-cut wood passed the same in 2½ hours; Midsummer and Midwinter are reckoned the best times to cut down trees. At Midsummer and Midwinter the sap has ceased to flow, and the extraneous vegetable matter intended for the leaves has been dislodged from the trunk, leaving it in a quiescent state and free from the germinative principle so liable to ferment. For such a reason wood cut down at those seasons is more durable and less liable to rot. Next follows a long account of the manner of seasoning wood, and charring or carbonising it; the latter process is declared to be highly preservative. By seasoning is meant not only the driving out the sap but the injection of some other fluid, so that the various preservative processes all come under this heading.

1. These processes we are told somewhat reduce the tranverse strength of the timber when dry.

2. The oils most proper to be used are linseed, rapeseed, or almost any of the vegetable fixed oils.

3. Animal oils are injurious to timber by rendering them brittle, though they preserve it from rottenness. Combined with saline matter it is preservative.

4. Fish oil used alone is ineligible; it loosens the cohesion of timber.

5. Mineral oils are good. Petroleum provides entire immunity from decay and the ravages of the white ant, but is too inflammable for use. Creosote is also inflammable, but is considerably cheaper.

The work is altogether worthy of careful study. It contains interesting accounts of the methods of injecting sulphate of copper, corrosive sublimate, and creosote, into the pores of wood. The question how best to preserve our telegraph poles is a home subject to many of our readers, and though the author does not advance any strikingly new ideas there are suggestions which cannot fail to arrest attention. For instance we do not remember to have ever seen it proposed to plant poles in the ground in an inverted position to that in which they grew. It is stated that such a course adds greatly to the durability of the pole for the simple reason that the valves of the sap vessels of the growing timber open upwards; and when that position is reversed the valves prevent the ascent of moisture from the soil into the wood.

ELECTRICAL SCIENCE IN FOREIGN JOURNALS.

(This column is devoted to a list of Electrical Memoirs published in Foreign Journals. Those of importance will be either translated in full or given in abstract.)

Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, tome lxxxi., No. 9, and 10, August 30, 1875, and September 6, 1875.

Electric Conductivity of Moderately Conducting Bodies.—M. Th. du Moncel.

Les Mondes, vol. xxxviii., No. 2, September 9, 1875.

Aurora Australis observed at the Rio de Janeiro Observatory on February 15, 1875; Observations on its Spectrum, and Conclusions therefrom.—M. Liais.—This aurora showed the red and green rays strong enough to allow their analysis by a spectroscope, and it presented the ordinary aspects of these phenomena, viz.:—Beams of divergent appearance, whose starting-points were upon an arc having its centre in the magnetic meridian in a point situated below the southern horizon, towards the direction of the compass's dip; the apparent convergence of the beams towards this point indicated their parallelism with the needle's dip. Reddish tints were at the base of the beams, and the spectroscope revealed (at their base) three very brilliant green rays and a red band. The measurement of the position of this band was (reckoned on the undulatory scale) expressed by the number 628·8; the position of the green rays being 556·9, 531·8, 516·3. The same was also observed in the green portion of the beams, where another band was found whose measurement was 468·8. These rays are found in the table of the sulphur rays by M. Salet. They had been noted by M. Angström before M. Salet, at a date when the ray 557 was not recognised as special to any known substance; they were likewise observed in the solar corona. It was at first concluded that auroras were cosmic phenomena, until sulphur (which exists in the air under diverse forms) revealed the ray and helped to decide that they are, incontestably, atmospheric phenomena. In March, 1867, M. Angström thought he detected the ray 557 in bright light; but M. Liais attributed it to the beam of an aurora situated in the direction of the zodiacal light. He proved that, in inter-tropical regions, the zodiacal light reveals no trace of rays. Auroras are thus phenomena very independent of both zodiacal light and solar corona; they are due to a sort of phosphorescence, caused by the passage of electric currents into sulphurous matters suspended in the air. The phosphorescent properties of sulphur and its compounds at a low temperature are well known.

Electric Conductivity of Pyrites.—M. Duffet.—See page 22.

Journal Telegraphique, vol. iii., No. 8, August 25, 1875.

The St. Petersburg International Telegraphic Con-Conference.—Third article.

D'Arlincourt's Autographic Telegraph.

New Organisation of the Italian Telegraphic Service.

International Service Regulation annexed to the International Telegraphic Convention of St. Petersburg.—This is a set of rules which Article 13 of the Convention provides, and whose terms may at any time be modified by mutual agreement of the contracting States.

PATENTS.

ABSTRACTS OF SPECIFICATIONS.

Improvements in electric telegraphs. George Allan, civil engineer, and James Wallace Brown, electrician, 18, Leadenhall Street, London. February 12, 1875. No. 525.—The main objects are (1), to record dots and dashes sent through submarine cables at a superior speed; (2), to translate or re-translate signals from one circuit to another at a superior speed; and (3), to relay or re-translate from land to submarine or insulated line without sending land line circuit through cable line or *vice versa*. The improvements consist:—First. In constructing what we call a contact, preferably of a metal bar provided with adjustable insulated platina discs or stops. The said bar is free to move in bearings, so as to be acted upon by an armature. Second. In a disc free to revolve in bearings, preferably on the armature above mentioned. Part of said disc serves as insulator and part as conductor; the conducting portion is provided with a local wire. The said disc bears against a metal surface also provided with a local wire. Various arrangements equivalent to the said disc may be used. Third. In the use of compensating springs in com-

bination with our movable contact, acting one against the other, and so adjusted as to maintain the armature of a relay or its equivalent in any required position. The springs and magnet act on the armature so as to compensate each other's action; one spring only may be used. Fourth. In connecting two circuits outside the relay or pecker, and connecting the armature of the relay or pecker to the line. The forward stop of the relay or pecker is connected through the right hand electro-magnet and the back stop through the left hand electro-magnet, or *vice versa*, to the opposite poles of the battery, the centre of the said battery being carried to earth. Fifth. In connecting the receiving relay or pecker through its armature or equivalent to a receiving battery. The centre of such battery is connected to earth, and the extreme positive pole to the right hand stop of relay or pecker, and the extreme negative pole to the left hand stop, or *vice versa*. Sixth. In winding the relays differentially. Seventh. In using two arms pivoted one on each side of an armature or its equivalent, of a relay or pecker or the equivalent of a relay or pecker, the said arms being placed angularly in relation to the armature but in the same plane. The free ends of the said arms are connected together by a bar which passes freely through a hole or slot in the armature. The ends of the said bar serve as contact points, and a parallel bar passes through the armature and has the ends touching the arms above described. Stops are provided and compensating springs are attached to the armature.

Improvements in signalling or working signals on railways and in the means or apparatus employed therein. William Robert Sykes, telegraph engineer, Nunhead, Surrey. February 23, 1875. No. 662.—This Provisional Specification describes a novel system of signalling or of working signals whereby it becomes impossible for a signalman to give the signal for a train to proceed until he has received a signal from the next station or signalling point that the previous train has passed. The system is in fact a combined lock and block system, the movement of a signal lever for a train to proceed having the effect of locking that lever until the lock is released by the movement of a lever at the next station or signalling point after the train has passed it, while the lever at the said next station cannot be moved until freed by the movement of a lever at a third station or signalling point shewing that the line between the second and third points is clear.

Improvements in the construction of the balancing apparatus or imitation telegraph line or cable to be used in duplex or other telegraphy, also of electric condensers and resistances. Herbert Arnaud Taylor, 7, Pope's Alley, Cornhill, and Alexander Muirhead, 159, Camden Road, Middlesex. February 24, 1875. No. 684.—With paper pulp is mixed a substance such as blacklead (plumbago) or precipitated metals, as gold, silver, copper, or other good conducting substance by which a moderate conducting power is imparted to the paper produced from the pulp.

APPLICATIONS FOR LETTERS PATENT.

2996. Walter John Kilner, Bachelor of Medicine, of 104, Ladbroke Grove Road, Kensington, Middlesex, for an invention for "Producing a continuous current of electricity by means of a rotating magnet or magnets, in combination with or without an apparatus for regulating the tension of the current."—Dated August 26, 1875.

GRANTS OF PROVISIONAL PROTECTION FOR SIX MONTHS.

2767. To Edward Griffith Brewer, of Chancery Lane, London, for the invention of "Improvements in the production of electric light, and in apparatus therefor."—A communication to him from abroad by Stephan Alexandrovitch Kosloff, of St. Petersburg, Russia.

2803. To Robert Morley, Secretary to the Improved Electric Telegraph Company, Limited, of 116, Palmerston Buildings, London, for the invention of "Improvements in electric telegraphs."—A communication to him from abroad by Julien Godener, of 57, Rue de l'Ouest, Paris, France.

2844. To Sir James Anderson, Knight, of 66, Old Broad Street, London, Edward Bull, electrician, and George Oscar Spratt, both of Porthcurno, Cornwall, for the invention of "Improvements in electric telegraph apparatus."

2919. To Augustin Billet, gentleman, of Lille (France), Rue Nationale, 30, for the invention of "An improved automatical apparatus applicable to electric telegraphs for regulating their working."

2921. To John Henry Johnson, gentleman, of 47, Lincoln's Inn Fields, Middlesex, for the invention of "Improvements in electric clocks or clockwork."—A communication to him from abroad by Emile Joanni Gondolo, of Paris, France.

NOTICES TO PROCEED.

2309. George Tomlinson Bousfield, of Sutton, Surrey, has given notice in respect of the invention of "Improvements in apparatus for the adjustment of magnetic needles."—A communication to him from abroad by George Iles, of Montreal, Quebec, Canada.

2434. William Stroudley, engineer, and Stephen Rusbridge, inspector, both of Brighton, have given notice in respect of the invention of "Improvements in apparatus for and in the method of signalling between parts of a railway train, parts of which apparatus are applicable to or for other purposes."

2729. Charles Edgar Wetton, of Field House, Harrow, Middlesex, has given notice in respect of the invention of "Improvements in magnetic apparatus and its application to various purposes."

2771. Sir Charles Wheatstone, Knight, of Park Crescent, Regent's Park, Middlesex, has given notice in respect of the invention of "Improvements in the mode of and apparatus for applying electricity to give telegraphic signals and work telegraphic relays."

2787. John Henry Johnson, gentleman, of 47, Lincoln's Inn Fields, Middlesex, has given notice in respect of the invention of "Improvements in producing electric signals, fires, and lights, and in the apparatus employed therein."—A communication to him from abroad by François Ernest de Mersanne, of Paris, France.

PATENTS

ON WHICH THE STAMP DUTY OF £50 HAS BEEN PAID.

2461. William Robert Lake, of the firm of Haseltine, Lake, and Co., patent agents, Southampton Buildings, London, for an invention of "Improvements in electro-magnetic signalling apparatus."—A communication to him from abroad by Frank Leonard Pope, electrical engineer, of Elizabeth, New Jersey, U.S.A.—Dated August 19, 1872.

PATENTS GRANTED IN FOREIGN STATES.

BELGIUM.

37,536. I. L. Pulvermacher, a patent of improvement for "Improvements in means of and apparatus for producing and applying electrical currents."—Dated July [illegible], 1875.—(Original patent, August 1, 1872.)

37,547. F. E. de Mersanne, for an imported invention of "A process and apparatus for producing electric signals, fires, and lights."—Dated July 30, 1875.—(French patent, May 31, 1875.)

37,588. Dignez Brothers and Co., a patent of improvement for "Improvements in telegraphic apparatus."—Dated August 5, 1875.—(Original patent, January [illegible], 1870.)

37,592. D. Rousseau, for an imported invention of "Improvements in circuit-closers for electric railway signalling apparatus."—Dated August 6, 1875.—(English patent, July 26, 1875.)

France.

106,112. Chutaux, for "An electric battery and exciting product."—Dated December 17, 1874.

106,113. Chutaux, for "An electric battery."—Dated December 17, 1874.

106,125. Lorémy, of Paris, for "An electro-chemical process for silvering or foliating plate-glass."—Dated December 31, 1874.

106,180. David, of Paris, for "An electro-magnetic alarm."—Dated December 29, 1874.

106,212. Dumoulin-Froment, of Paris, for "Mechanical contrivances for regulating electric apparatus, such as telegraphs, clocks, registering apparatus, and especially Morse dial-telegraphs."—Dated December 31, 1874.

101,936. Lontin, for "A dynamo-electric machine."—Dated December 31, 1874.—(Certificate of Addition.)

United States.

164,270. *Galvanic Batteries.*—Howard P. Dechert, New York.—Interposes a secondary or local action copper pole between the poles of a sulphate of copper battery, and near the zinc pole, in order to prevent the accumulation of copper upon the zinc pole when the sulphate of copper solution rises too high. A secondary or local circuit pole, separate and distinct from the primary pole, applied in connection with a primary pole, substantially as and for the purpose set forth.

164,661. *Electrical Billiard Registers.*—Chas. H. Russell and Julius Sax, assignors to Bernhard Ahrens, all of London, England.—Two index fingers, one for each ball, carried on same shaft, one directly, one by a sleeve, each actuated by its own electro-magnet and circuit. First one around actuates mechanism scoring one game on the smaller or game dials. 1. The combination of the armature levers C C, the intermediate gearing a_4 a_5, and the index hands, substantially as described. 2. The combination of the armature levers, the intermediate gearing, and the index hands, with the game recording mechanism consisting, essentially, of the loose pulley M with its discs and stops, the intermediate gearing, and the recording dial and index, as described. 3. The combination of the pusher lever C, and the stop d_1 for limiting its backward movement, as described. 4. The combination of the pusher lever C, and the stop d^2 for limiting its forward movement, substantially as described. 5. The combination of the pusher lever C, and the stops d^1 d^2 for limiting its forward and backward movement. 6. The combination of the index hands a^1 a^2 and the gearing a^4 a^5, having the weight E, as described. 7. The combination of the studs N, the spring stops m^1, loose pinion M, and the connecting gearing, as described.

164,723. *Electric Toys.* Wm. Decker, New York.—Electrical excitation in the glass, resulting from rubbing, causes the figures to dance and execute various gymnastic feats. The electric toy composed of the glass plate A, which is supported on legs B, and of the rubber C, combined to affect the figures D D, which are placed beneath the glass, substantially in the manner herein shown and described.

164,807. *Galvanic Batteries.* Theophile Chutaux, Paris, France.—For withdrawing the spent liquid. The tube J, provided with an exhaust globe K, and extending down into and secured in a tube *f*, which is secured in and extends to the bottom of the porous cup, and is made of non-conducting material, substantially as and for the purpose set forth.

6,508. *Duplex Telegraphs and Circuits therefor.* Jos. B. Stearns, Boston, Mass., assignor to the Western Union Telegraph Co., Patent No. 132,932, dated Nov. 12, 1872.—"Bridge duplex" circuits arranged to pass currents of sending station around receiver of such station. 1. A duplex telegraph having a receiving instrument placed between the main line and an artificial line, and a connection from the transmitting key to both sides of the receiving instrument, so that such receiving instruments may be at a neutral point with reference to the electric pulsations produced at that station, substantially as set forth. 2. A duplex telegraph containing a receiving instrument placed at a neutral point, and an electro-magnet in the artificial line, substantially as set forth. 3. The combination of the receiving instrument with the resistances R, R_1, R_2, in the manner and for the purpose set forth. 4. The combination of the receiving instrument and the resistances R, R_1, R_2, with a series of smaller resistances, *r*, as and for the purpose set forth. 5. The combination of the receiving instrument A with the electro-magnet B, as and for the purpose set forth.

164,921. *Electric Fuses.*—C. L. Kalmbach, Richmond, Va.—1. A fulminate primer constructed by sealing a glass vial containing the fulminate of mercury hermetically in a chambered wooden block, substantially as set forth. 2. In combination with the firing wires, a quill within which the ends of the wires are adjusted in proper relation to one another, substantially as set forth.

164,940. *Train Telegraphs.*—A Ryder, Oakland, Cal.—Designed for use with that class of signals in which the breaking of an electric circuit extending from end to end of the train sounds a signal upon the engine. The plugs or pistons E moving in the case A A, and provided with a guiding slot *c*, and spring *a*, so that after the plug has been drawn back the spring arm causes the two ends of the cable to become re-united, and perfect contact be had between the wires of the cable, substantially in the manner as herein set forth and specified.

165,055. *Telegraph Wire Couplings.* — Samuel M. Barbour and Frank A. Page, Philadelphia, Pa.—A block of metal having two apertures for the passage of the wires, and provided with shouldered chambers adapted to retain the ends of the wires after they are bent back upon themselves, as set forth and described.

165,064. *Electro-Magnetic Engines.*—Theophile Chutaux, Paris, France.—The two parts of the armature are acted upon successively, the lower drawing down the upper to a point where the electro-magnet can act forcibly upon it. In an electro-magnetic engine, the armature lever R, constructed in two parts, hinged at one end to the frame of the apparatus, one part being connected at its opposite end to the connecting rod S of the walking-beam, and the other provided with a hook, *h*, adapted to work within the first-mentioned part, substantially as herein specified.

165,090. *Burners for Electrical Gas Lighting.*—Saml. Gardiner, jun., Washington, D.C.—1. The insulated globe holder I, in combination with the wires J and K, the one connecting with one burner, A, through its electrode E, and the other with the next succeeding burner by the electrode F, with the said holders in the circuit throughout the series of burners, substantially as described. 2. The negative electrode E, as a part of, and a prolongation of, the separate metallic nipple C, and in combination with the burner-tip D, substantially as and fot the purposes herein set forth. 3. The combination, with the burner and the metallic globe holder I, of the wires J K, connecting said globe holder with the negative electrode E and the insulated wire G' of the positive pole passing through and beneath the globe holder, whereby a single burner may be lighted through the medium of said globe holder, as herein set forth.

165,063. *Dial Electric Telegraphs.* — C. T. Chester, Englewood, N. J.—One train controlled by electro-magnetic escapement, actuates pointer, another controlled by the keys, the transmitting break wheel, both brought to a common axis, N. On lid of containing box is placed ordinary key and bell magnet. Lug on lid, when closed, taking on switch, breaks circuit to dial magnets, and closes circuit to bell magnet and key, 1. The combination of a shaft turning within a fixed tube or sleeve, and another hollow or tubular shaft turning without the said fixed tube, with mechanically driven trains of wheels, for the purpose of causing independently driven shafts, wheels, or devices to revolve upon a common axis of motion. 2. In connection with electric telegraphic cir-

cuits, the combination of two independent motors, carrying, respectively, a circuit breaking device, and recording or receiving devices controlled by a magneto escapement, and so arranged that the shaft governing the motion of the circuit breaking device and the shaft causing the recording devices shall have a common axis of motion for the purpose of electro-telegraphy, substantially as set forth. 3. In combination with any electro-telegraphic apparatus contained in a box, wherein two or more devices having separate magnets may be alternately called into use, an attachment fastened to and moving with the lid of the box, and a switch or commutator within the box, so that the movement caused by the opening or closing of the box shall cause connections with the circuit to be made alternately with one or the other magnets, substantially in the manner and for the purposes hereinbefore described.

COMMERCIAL NOTES.

The traffic receipts of the Submarine Telegraph Company for the month of August last amounted to £9864, and for the corresponding month of the preceding year to £9195.

The estimated traffic receipts of the Anglo-American Telegraph Company on the 7th inst. were £1540; on the 8th, £1450; on the 9th, £1430; on the 10th, £1480; on the 11th, £1370; on the 12th, £360; on the 13th, £1220.

The traffic receipts of the West India and Panama Telegraph Company (Limited) amounted in June, 1875, to £3482 as compared with £2865 in the corresponding period of 1874.

It is stated that, in consequence of a forged bill for £7000 having been negotiated, the directors of Hooper's Telegraph Works intend to appeal at once to the shareholders, there being no more capital to call up. It has been in contemplation for some time past to call a meeting of shareholders, owing to the difficulty of getting in a large amount due for work done.

The Eastern Telegraph Company have issued a circular containing new regulations, adopted at the Conference at St. Petersburg, which come into force on the 1st of January next. The uniform rate for messages to India will be 4s. 6d. per word, but the tariff for places beyond India and to South America is not yet settled. European messages will be charged, as at present, by a tariff of 20 words, including names and addresses; but those for places out of Europe are to be paid for at so much per word, the sender paying only for the number of words sent. Messages may be repeated, to insure greater accuracy, on payment of half the usual rates additional, and the hour at which a message has been delivered can be notified to the sender on payment, if in Europe, of the charge for 20 words, and out of Europe for 10 words. No secret letter messages will be received from the public for India, Penang, Singapore, or China. The charge for an European message which has been delayed 48 hours, or an extra-European message which has been delayed 288 hours, will be returned to the sender if the delay has arisen from any other cause than an interruption of the wires, provided application for reimbursement be made within two months in the case of European, and six months in extra-European messages.

The Indo-European Telegraph Company have sent out a circular containing similar information. They refer also to the use of code words, which are allowed on condition that they do not contain more than a maximum of ten characters in lieu of seven syllables as at present.

The West India and Panama Telegraph Co. give notice of the interruption of the Santiago de Cuba—Jamaica and Punta Rossa—Key West Cables. By the recent opening of the Para-Demerara cable, however, direct communication by wire is established viâ Lisbon and Pernambuco with Para, Cayenne, Demerara, the Isthmus of Panama, and all the West India Islands except Cuba.

The Anglo-American Telegraph Company have reduced their rate for messages to New York to 1s. per word. The name of the place from which messages originate are transmitted free of charge.

The cables of the Direct United States Cable Company were opened yesterday for the transmission of messages. In consequence of the reduction of the tariff rates of the Anglo American Company the following rates have been adopted:—To Canada, New York, New Jersey, Pennsylvania, Delaware, Maryland, District of Columbia, 1s. per word. To Ohio, Indiana, Illinois, Michigan, Wisconsin, St. Louis, (Ms.), 1s. 4d. per word. To Missouri, Kansas, Nebraska, Iowa, Colorado, Wyoming, Utah, Nevada, California, 1s. 8d. per word. The name of the place from which messages originate are transmitted free of charge.

Telegrams for the United States and West Indies are now received at M'Lean's Telegraphic News Exchange at reduced rates. Subscribers to the Exchange, which will be opened on Monday, October 4, will have the privilege of sending despatches at a cost of one word for the address and signature inclusive.

The Western and Brazilian Telegraph Company (Lmited) announce that telegrams for Valparaiso and Chili can again be accepted by the Eastern Company, or any postal telegraph office, if addressed and prepaid to their destination.

TELEGRAPH SHARE LIST.

Amount per Share.	Name of Company.	Amount paid up.	Closing Quotations.
£		£	Sept. 15
Stock	Anglo-American	100	[illegible]
10	Black Sea	All	[illegible]
10	Brazilian Submarine	All	[illegible]
10	Cuba	All	[illegible]
10	Ditto, 10 per cent Preference ..	All	[illegible]
10	Direct Spanish	9	[illegible]
10	Ditto, 10 per cent Preference ..	All	[illegible]
20	Direct United States Cable	All	[illegible]
10	Eastern	All	[illegible]
..	Ditto, 6 per cent Debenture	..	[illegible]
10	Ditto, Exten. Australia and China	All	[illegible]
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TO ELECTRICIANS EVERYWHERE.

SINCE the day when Electricity was first discovered, until now, its vast importance and its high destinies have grown upon the human mind. Fresh phases of its power, fresh results, new means of obtaining and governing its action, and multiplied ends to which it may be turned, have constantly discovered themselves; till to-day it stands out as one of the grandest subjects presented to the scientific and practical world for investigation and research. Perhaps, however, no other Science or Art has exhibited so extraordinary a concurrence of anomalies. It is at once the most terrible monster and the most humble and obedient servant, its action is at one moment beneficial, at the next destructive; its range is boundless, yet it may be "cabined, cribbed, confined" at ease; it is everywhere present, while its nature is only imperfectly understood; and, to crown all, although it is one of the most important agents in the action and the phenomena of the universe, and increasing knowledge of its applicability to the needs of our race is of the utmost importance, no direct means of ascertaining the thoughts and discoveries of its students, or of bringing them before the scientific and mechanical community, at present exist. Attempts have been made to supply this want, and journals have been started with the professed object in view of making public all that is known or can be learnt of Electricity in all its branches. But they have degenerated into unscientific records of unimportant events, and the purpose for which they were established has been lost sight of. Thus it comes that—while Engineering, Chemistry, and other Applied Sciences have all their representative recognised organs—the Electrician finds himself without any current journal from which he can learn the events which are daily occurring of peculiar interest to himself.

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July 1st, 1875.

London: Printed and Published by the Proprietor, WILLIAM CROOKES, at the Office, Boy Court, Ludgate Hill, E.C.
September 16, 1875.

THE

ELECTRICAL NEWS

AND

Edited by Wm. Crookes, F.R.S., &c.]

TELEGRAPHIC REPORTER.

[Registered for Transmission Abroad.

Vol. 1.—No. 13.] Thursday, September 23, 1875. [Price, 4d. Post Free, 4½d.

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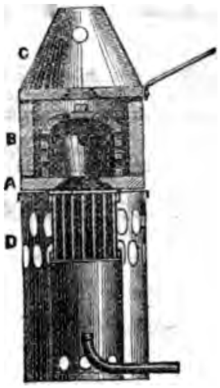

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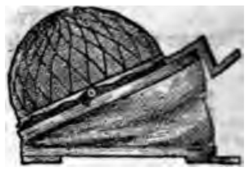

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VOL. I. No. 13.

'RIC CONDUCTIVITY OF MINERAL SUBSTANCES.*

By the Count Th. du MONCEL,
Membre de l'Institut de France.

presented to the Academie des Sciences de ber 5 and 26, 1874, I remarked that electric cross minerals is most often accompanied ergetic polarisation effects, which result weakening successively (and in enormous he electric current traversing them; also first weakening it and afterwards increasing utset I had attributed these effects to local ped in the interior of the stones under the the traversing current—actions which, by th the effects of polarisation, might be able, a limit, to account for the observed results. ne nature of these local actions? That was d to be cleared up. To answer this question, ughly precise the facts, I had a certain ne samples of different kinds cut with great ially study them. One of these samples— mong all the others by reason of the con- cts it affords—has enabled me to give very ons in this respect, and bring to light very ew phenomena to which I desire to draw

The stone which has supplied me with such curious observations is a grey flint already spoken of in my communication of October 5, 1874, and which I met with in the calcareous stone quarries of Heronville, near Caën. I had a small prism cut out of this stone (about 38 m.m. long, 24 wide, and 5 thick) two faces of which I had carefully polished; and it was not experimented upon until after it had been preserved for seven months in an extremely dry place. Notwithstanding its dryness, the conductivity of this stone was so great that in order to ascertain the variations of the current's strength traversing it from a Daniell battery of 12 small elements, I was obliged to add a shunt of 4 kilometres resistance to my galvanometer of 36,000 turns. The results obtained from this stone being altogether peculiar, I studied them parallelly with those obtained from other stones as represented in Table I.

Platinum electrodes were used with surface of 240 square millimetres (which enveloped the two ends of the stone), and they were separated by an interval of 15 millimetres.

In addition to these, other minerals were experimented upon; among them yellow and black agate, cornelian, jasper, amethyst, malachite, amazon stone, opaque Iceland spar, and porphyry; but they gave no lasting deflection, which scarcely reaching 8 to 10 degrees, disappeared at the end of two or three minutes.

Of course the current which I have called in the preceding table "polarisation current," is that obtained when joining the platinum electrodes directly with the galvanometer, and after removing the electric source from the circuit. By unmounting these electrodes, and wiping them, as well as the stone, the continuance of these polarisation currents may be diminished; but they nevertheless persist after this operation, and those developed in

Minerals.	Principal Current.			Polarisation Current.			Principal Current Reversed.			Polarisation Current.		
	Commencement.	After 1 Minute.	After 10 Minutes.	Commencement.	After 1 Minute.	Duration.	Commencement.	After 1 Minute.	After 10 Minutes.	Commencement.	After 1 Minute.	Duration.
flint from Heronville,	90°	70°	75°	90°	88°	33'	85°	66°	73°	90°	87°	5 h
h shunt of 2 kilos. ..	90	69	71	90	86	40	90	61	64	90	80	25'
v marbled flint	90	80	84	51	20	7	90	75	79	33	13	3
	90	81	86	56	24	12	90	74	78	32	13	4
ous quartz	54	38	39	14	10	5	—	—	—	—	—	—
	—	33	39	—	—	—	—	—	—	—	—	—
	60	40	46	—	—	—	64	60	39	12	9	5
n sardonyx agate ..	47	31	33	0	0	—	57	31	27	0	0	—
parent agate, slightly ic striated	19	13	28	0	0	—	42	16	31	0	0	—
	43	30	39	0	0	—	54	39	42	0	0	—
	43	27	40	0	0	—	42	15	29	0	0	—
agate, circularly striated	23	19	17	0	0	—	25	20	13	0	0	—
flint	31	20	13	0	0	—	—	18	12	0	0	—
, oak-red	26	17	13	0	0	—	26	17	13	0	0	—
n serpentine	25	16	10	0	0	—	20	14	11	0	0	—
entine, deeper colour ..	22	15	14	0	0	—	20	15	13	0	0	—
s lazuli	29	13	11	0	0	—	21	11	10	0	0	—
fram, with shunt of 128 lometres	90	73	72	0	0	—	90	71	72	0	0	—
ish white stone from merica, with shunt of 28 kilometres	90	76	38	25	10	2	70	42	28	—	10	0·5
1 limestone, with shunt f 64 kilometres	55	41	10	32	13	11	37	21	15	16	12	15
n marble (old)	58	36	30	4	—	3	58	35	21	0	0	—
ers' slate..	90	70	58	12	—	4	90	65	46	11	8	2
tored porcelain	22	15	7	0	0	—	19	13	9	0	0	—

* Communicated by the Author.

the flint from Heronville, after having fallen from 80° to 20°, have still lasted fifteen minutes after being wiped.

However, the polarisation produced in the stones is not completely destroyed even when the needle has returned to zero. A prolonged rest of the stone, or its being heated, can alone completely destroy the polarisation.

The experiments referred to in the preceding table clearly show that polarisation effects exist within most minerals; and may even sometimes give rise to relatively strong secondary currents. But what is the nature of this polarisation? how can it intervene to increase, after a certain period of weakening, the strength of the current which provokes it? This is a delicate question. If electric conductivity across stones were only the result of an electrolytic conductivity effected in the interior of a damp conductor, these effects might be explained by the supposition of pre-existent local couples. In a work I published in *Les Mondes*, of November 19, 1874, I showed that we could indeed obtain them by introducing a small couple of this class into a liquid conductor traversed by a strong current. But with stones as hard and as dry as those I experimented upon, it is difficult to admit, at least for those which furnished the most energetic polarisation currents, the presence of this damp conductor; and we are naturally led to attribute the polarisation in question to *electrification* of the bodies by *electrotonic* means, and the influence of condensation determined by the platinum plates. We know that to an effect of this kind is due the electric flow between two glass plates under the influence of the induction spark; and the effects produced on submarine cables are only more or less complex derivations. The researches made in England upon this class of phenomena have demonstrated that the condensing action exercised by a current on a dielectric results at first in provoking an *electrostatic action* which is read on the galvanometer, placed in connection with the current, by a "charge current;" then succeeds an electric flow across the insulating material; and lastly a sort of absorption which constitutes the phenomenon called in England *electrification*, and which I here look upon as a successive molecular polarisation. Of these three actions, transmission across the insulating body is the only one which continues to act upon the galvanometer, and it ought therefore to indicate the different phases of the variable period in which the transmission passes. To assure myself whether the different circumstances of the observed phenomena were explainable in this order of ideas, I undertook from this point of view a series of experiments which led me to the curious results announced at the beginning of this paper.

I became at once assured that the polarisation current produced under the conditions already referred to *has a duration so much the greater* as the closing of the *polarising or principal* current is effected *for a longer time or a greater number of times in the same direction; even when before each closure the successive polarisation currents are cancelled from the galvanometer.* In this latter case if the successive closings of the current are equal in duration, the polarisation currents which follow, although of very unequal duration, maintain really the same strength, and the polarising current alone decreases in energy. On the other hand, if, after having passed the polarising current for a certain time through the stone, it be directed in a contrary direction of least duration *a superposition of contrary polarities is produced.* This signifies that the polarisation current determined in the first place is not in any case destroyed by the second; and, according to the duration of the latter in relation to the former, we can obtain either a simple weakening of the first current, or its momentary annihilation, and its reappearance at the end of a shorter or longer time. It then even persists for nearly as long a time as if it had not been momentarily dissembled. If the polarising current be alternately reversed across the stone after the polarisation currents resulting from it have been cancelled, the effects are symmetrical on all sides. One is able to judge of these different effects from the following experiments on the Heronville flint:—

1. *Positive Currents through the Stone from Right to Left.*

Polarising Current.	Strength of the Polarising Current.		Polarisation Currents.		Duration of the Polarisation Currents.	
	Ser. 1.	Ser. 2.	Ser. 1.	Ser. 2.	Ser. 1.	Ser. 2.
1st closing for 32"	64°	55°	55°	55°	13' 15"	13' 35"
2nd ,,	60	48	60	59	22 40	19 40
3rd ,,	60	43	62	56	29 10	23 40

2. *Negative Currents Across the Stone from Left to Right.*

Polarising Current.	Strength of the Polarising Current.		Polarisation Currents.		Duration of the Polarisation Currents.	
	Ser. 1.	Ser. 2.	Ser. 1.	Ser. 2.	Ser. 1.	Ser. 2.
1st closing for 32"	79°	58°	48°	52°	9' 50"	9' 12"
2nd ,,	50	49	45	46	15 30	15 30
3rd ,,	38	33	44	42	18 28	19 00

To verify the effects produced by two contrary currents of unequal duration upon the resultant polarisation currents, I sent my current directly from the battery across the stone for ten minutes; and, after having ascertained the reading from the polarisation current to be 87°, I reversed the direction for 32" only. The resultant polarisation current from this was not developed; all that was recorded was that the reading instead of being 87° fell to 72° in 1' 20". At the end of five minutes the reading was 53°. I again sent the current through the stone for 32" as before, and the polarisation current then obtained *ended in totally overpowering, or dissimulating, the first.* At first an inverse deflection of 90° was furnished, which became 18° at the end of 1' 10"; *and, after changing sign it became fixed for some moments at 32° on the opposite side:* then it commenced to lower, and was not completely obliterated till the end of 3 h. 45' after stopping for a long time at 10°.

If we compare the successive lowering of the strength of a polarisation current submitted, as the preceding one, to inverse actions, with the lowering of a similar current abandoned to itself, we perceive that these actions exercise no notable influence. Here, indeed, are the different phases of the strength of the previous current left to itself, and noted every five minutes—85°, 61°, 34°, 17°, 12°, 10°, 8·75°, 8°, 7·75°, 6·5°, 6·5°, 5°, 0°.

If we bring these polarisation effects near to those which permanent magnets present, a very remarkable analogy may be noticed. In the two cases, indeed, the exciting action may more or less deeply penetrate the material according to its energy or its duration, and contrary polarities may be superposed without destroying themselves reciprocally.

In the preceding note I was almost entirely occupied with one kind of stone, and naturally I have not been able to indicate the general characters which differentiate various minerals from my present point of view. Nor have I spoken of the effects produced upon them by moisture and heat—effects from which, theoretically, important conclusions may be deduced. This double question will now concern us.

If we cast a glance over the table already given, it will be immediately seen that for a certain number of stone samples *the strength of the current traversing them goes on increasing with the duration of the circuit's closure*, whilst *for the others it continues to diminish.* Nevertheless, among the stones which determine this latter effect, there are those in which this successive weakening of the current is continuous, and others in which it stops after a longer or shorter time, rarely exceeding ten to twelve minutes. Hard stones belong to the latter case; and if, in the table in question, only a successive lowering is verified, it is because observations were discontinued too soon. Soft and porous stones, on the contrary, react upon the current, so as to weaken it in a period proportionately greater or less according to their hygrometric condition; and these proportions are sometimes so great that the current is annulled—provided, at least, that hygro-

metric conditions and temperature of the surrounding medium do not favour conductivity. Some idea of this difference of action may be arrived at from the following table, a record of experiments made upon the stones just referred to. Each experiment was carried on for an hour, and even more.

	At the Beginning.	Five Mins. after.	Ten Mins. after.	One Hour after.
Onyx china red	(21°—15°)	13·5°	12·5°	12°
„ „ current reversed	(20—15)	12·0	12·0	12
Green serpentine	(19—13)	10·5	10·0	10
„ „ current reversed	(18—13)	11·5	11·0	11
Lilac agate	(20—15·5)	14·0	13·5	14
„ „ current reversed	(27—17)	13·0	12·0	11
Sardonyx agate	(38—26)	20·0	21·5	33
„ „ current reversed	(60—36)	31·0	26·0	26
Gun flint	(22—15)	14·0	14·0	16
Caen stone	(90—83)	41·0	30·0	19
„ „ cu r t reversed	(90—69)	58·0	48·0	32

In certain stones—and resinous quartz, as well as Sardonyx agate, are remarkable examples—the strength of the current increases when it traverses the stone in a certain direction, whilst, on the contrary, it will diminish when in the opposite direction. There, moreover, exist great discrepancies between the figures representing the conductivity of the same stone obtained at different moments; and these discrepancies are still met with in the rapidity of augmentation or weakening which the current experiences when it is placed in the conditions referred to above. These divergences result from the changes of the physical conditions of the surrounding medium and of the stone, and the persistent polarisation effects whose existence was pointed out in my previous communication; they react in a different manner according to the direction of the current, as will be observed further on. We may always prejudge, from the manner in which the current behaves in traversing the stone, what will be the resulting polarisation current. In fact, when, with hard stones, the increase of *the principal current's strength is markedly shown*, and that only for one direction, we may almost generally take for granted *that polarisation currents more or less lasting will be produced*.* But when, after experiencing a successive lowering, *the current maintains an even strength*, or at least departs but little from it, either in one direction or another, we may assume that *no polarisation current will be developed*; at least, with the electric source employed. Indeed, none of all the stones I have spoken of, excepting Sardonyx agate which furnishes an increase of current strength in a single direction, will produce polarisation currents, however long circuit may be closed; experiments have been continued on closed circuit for thirteen hours with gun-flint, which furnished a constant deflection of 16°.

The results are different with soft and porous stones, and the reason is this. They are always able to set up a polarisation current whenever the electric potential suffices; but its duration, as well as its strength, depends essentially on the greater or less humidity of the stone. Thus, when the sample of Caen stone, dried, gave a polarisation current of 13° and 11 minutes duration after 10 minutes electrification, only 44° (reduced to 9° after 20 minutes) were obtained from the same electrification when the stone had been left to itself twenty-four hours and was consequently moist. It must be stated, however, that the polarising current, instead of falling from 41° to 10°, as in the first case, was only weakened one degree. Before attempting a theory for all these effects, I must enter into some details respecting the influence of moisture upon them, as well as the temperature of the surrounding medium. In order to explore the nature of these two almost simultaneous influences, a series of experiments were undertaken, in which sometimes the conditions of moisture, and sometimes those of temperature, were varied.

To study the action of dampness, I simply took the minerals enumerated in the experiments already described which furnished no deflection, and, after leaving them for thirty hours in a moist recess, I experimented on them at an hour of the day when the temperature of my laboratory was as nearly as possible the same as at the time of my first experiments. Now most of them became conductors, even after carefully wiping them. Malachite, black agate (Báignie), and a greenish jasper spotted with yellow formed the only exceptions. The others gave the following results:—

				Current Reversed.		
	Commencement.	Five Mins. after.	Ten Mins. after.	Commencement.	Five Mins. after.	Ten-Mins. after.
Rich green jasper	(55—30°)	21·0°	19·0°	(51—29°)	18·5°	16·0°
Yellow agate	(10—8)	8·0	8·0	(14—10)	11·0	14·0
Brown jasper ..	(19—13)	12·0	13·0	(22—13)	11·2	11·5
Porphyry	(10—8)	6·5	6·5	(11—8)	6·5	6·5
Hard cystis	(15—10)	9·0	9·0	(10—8)	7·0	7·0
Sandstone from May	(10—5·5)	—	—	(4—0)	—	—
Granite	(35—25)	18·0	15·5	(25—13)	10·0	9·0

All these stones, naturally, furnished no appreciable polarisation current.

I afterwards examined other specimens which had already given deflections (and which I put into the recess after passing them through the stove), to see if they would furnish any notable increase of conductivity. The augmentation was considerable. I may thus conclude that *hard and soft stones*, with a few exceptions, including those minerals which have yielded to the effects of fusion and crystallisation, *absorb the atmosphere's moisture more or less, and thereby become conductors.*

(To be continued).

NEW EXPERIMENTS ON ELECTRO-MAGNETISM.*

By EMILE GIROUARD.

1. Take a hollow bobbin covered with insulated copper wire, and enclosing in its interior an iron bar of the same length.

Adjust two iron connections to the two scales of a balance.

Cause a constant current of determinate strength to pass through the wire around the coil, and suspend the scales loaded with weights from the poles, A and B, of the bobbin.

We then observe that the magnetic power of the bar contained in the bobbin balances at A and at B a weight, which let us assume to be 500 grms. This will give 1000 grms. by uniting the attractive forces of the two poles.

2. Place in the same bobbin a bar five or six times longer than itself, until one end of the bar is flush with one end of the bobbin. Replace the scales. It will then be found that the extremity B of the iron bar can bear no more than 500 grms., whilst A sustains almost 1000 grms.

3. Increase the length of the preceding bar twenty or twenty-five times, and it will be observed that the magnetic force which in the first experiment was represented by 500 grms. at A is now equal to about 8000 or 10,000 grms. This augmentation may extend to 15,000 grms.

* It may happen that these currents do not show themselves under the influence of a polarising current of short duration; but, by augmenting this duration, we always end in obtaining them. This is noticed when experimenting with Calcedony agate. With the polarising current closed for ten minutes, no appreciable polarisation current is produced; but, closed for half an hour, it will appear with a strength of 12°, and will last about one minute. Truly the strength of the polarising current is, then, more than doubled, for it passes from 18° to 49°. Sardonyx agate supplies analogous conclusions. With a 10 minutes closed current there was no polarisation current; one of 10° was produced after one hour and a half, during which time the polarising current had passed through the following phases:—(38°—26°)—20°—21·5°—30°—33°—34° (observations being made every half-hour after 21·5 were obtained). The duration of the p risation current thus set up was 8 minutes.

* Communicated by the Author.

under certain circumstances, whilst the attraction at B becomes completely *nil*.

It is very interesting to follow up the bar with a magnetised needle, for then the diminution of attractive force and its laws are easily noted. It may be specially remarked that, though we reverse the direction of the current, the pole A is always the only one having an attractive power, and B is always quite at zero.

4. By putting the bobbin in the middle of the long bar the attractive forces of the two poles A and B are very weak, and nearly equal.

When I made these experiments for the first time in 1873 at Chartres, before the Scientific Society of Eure and Loir, I gave to the phenomenon the name of *magnetic condensation*, because of this kind of compression of magnetism to a single pole; and I then constructed a series of instruments with magnetic condensors, for the purpose of obtaining as much power from one single small electric bobbin as may be obtained from two larger ones joined together in the ordinary style. Solely for greater convenience, and in order to take up less space, I gave to my condensers a lamellar form. I must add, in closing, that this arrangement, which may be very useful when great power is desired, is inapplicable when a great rapidity of magnetisation is wanted. I have also succeeded in applying this principle to the construction of magnetised needles of a particular form.

I will just point out a remarkable induction phenomenon which is produced in an electro-motor made upon this principle. Although all the communications be fixed upon non-metallic bodies, and the wires be well insulated from the bobbin, sparks will be constantly thrown from one condenser to the other. I have named these sparks, *magnetic induction sparks*. This phenomenon has since been noted by many persons, and is always produced outside of the electric communications.

ON THE ORIGIN OF ATMOSPHERIC ELECTRICITY.

According to M. Becquerel, solar spots, which are sometimes 16,000 leagues in extent, appear to be cavities by which hydrogen and various substances escape from the sun's photosphere. But hydrogen, which appears here to be only the result of decomposition, takes with it positive electricity, which spreads into planetary space even to the earth's atmosphere and to the earth itself, always diminishing in intensity because of the bad conducting power of the successive denser layers of air and of the crust of the earth. That would then only be negative, as being less positive than the air. The diffusion of electricity through planetary space would be limited by the diffusion of matter, since it cannot spread in a vacuum.

That gaseous matter extends farther through space than the distance which is generally assigned to the earth's atmosphere will be proved by the fact that auroras, which are due to electric discharges, are produced at heights of 100 and 200 kilometres, where some gaseous matter must exist.

M. de la Rive agrees with M. Becquerel as to the electrical origin of the aurora, but considers that the earth is charged with negative electricity, and is the source of the *positive* atmospheric electricity, the atmosphere becoming charged by the aqueous vapour rising in tropical seas. The action of the sun, he considers, is an indirect action which varies with the state of the sun's surface, as shown by the coincidence in the periods of aurora and sun spots.

In the accounts of travellers in Norway we often read of their being enveloped in the aurora, and perceiving a strong smell of sulphur, which must be attributed to the presence of ozone. M. Paul Rollier, the aëronaut, who descended on a mountain in Norway 1300 metres high, saw brilliant rays of aurora across a thin mist which glowed with a remarkable light. To his astonishment an incomprehensible muttering caught his ear; when this ceased he perceived a very strong smell of sulphur, almost suffocating him.—*Manual of the Natural History, Geology, and Physics of Greenland.*

THE PRESERVATION OF TIMBER BY COPPER SALTS.

By M. ROTTIER.

As is well known, one of the principal processes of preserving wood consists in causing a solution of cupric sulphate to penetrate into its ligneous fibres. The great interest which attaches to this method induces me to recount the following experiments on this subject, undertaken in the laboratory of Prof. Douny, at the University of Gand:—

I set myself two distinct questions:—(1.) The causes which (at the end of a certain time) conduce to the destruction of prepared wood. (2.) Whether it is possible to prolong its durability by employing methods different from that actually in use.

Ligneous material impregnated with sulphate of copper is not preserved indefinitely under ground; whatever care may have been exercised in its preservation, it always alters in a variable period of time. This is easily explained. Under the influence of certain causes the prepared timber gradually loses the small quantity of copper fixed in its *cellular tissues*. So long as the wood retains a certain quantity of copper, rot is resisted, but directly the copper disappears the wood is acted upon like unprepared timber, and is rapidly destroyed under ground.

Having dried some chips of poplar blea, or inner bark, I thoroughly impregnated them with a solution of pure cupric sulphate, containing 1·5 grms. of crystallised sulphate for 100 of water. I did not employ pressure to obtain a complete penetration of the liquid into the pores, as the wood was so thin that simple immersion was enough for the purpose. When washed and dried again, the prepared chips were buried in a box containing ordinary mould kept constantly moist with periodic sprinklings of rain water. From time to time the chips were taken up, and the quantities of metal they retained were ascertained. The results of this analysis are contained in the following table:—

	Period of Burial. Days.	Copper remaining in the Wood, calculated in the condition of Crystallised Sulphate. Grm.	Observations.
1 grm. of prepared and washed wood	0	0·00410	
1 do. do.	68	0·00250	Perfectly preserved.
1 do. do.	117	0·00225	Studded with black spots.
1 do. do.	179	0·00170	Almost completely destroyed.

The conclusion drawn from this experiment, in an evident and direct manner, is that the wood owes its preservation to the presence of the copper, and that as fast as it loses the metallic salt so fast is it destroyed.

As regards the second question, there are three causes under the influence of which the copper salt is taken away from the wood:—

1. The presence of iron.
2. The presence of certain saline solutions.
3. The presence of carbonic acid.

The action of metallic iron upon wood prepared with sulphate of copper has been so well studied by such men as Van der Sweep, Kuhlmann, Paul Thénard, and Hervé

Mangon, that I have not thought it necessary to experimentally enquire further.

But I have deemed it of sufficient importance to examine up to what point the presence of an iron salt in cupric solutions is injurious to the proper preservation of wood. For this purpose a certain number of wood-chips—as large as the previous lot—were saturated with sulphate of copper solutions containing different quantities of sulphate of iron. The following table gives a list of how long these pieces were preserved:—

Chips.	Weights of the Chips.	Composition of the Liquids used in preparing the Chips.			The chips were completely destroyed under ground at the end of—
		$CuSO_4 5H_2O$.	$FeSO_4 7H_2O$.	H_2O.	
	Grm.	Grms.	Grms.	Grms.	
1	0·25	0·00	1·50	100	56 days.
2	0·25	0·50	1·00	100	83 ,,
3	0·22	1·00	0·50	100	97 ,,
4	0·22	1·20	0·30	100	100 ,,
5	0·22	1·30	0·20	100	103 ,,
6	0·19	1·40	0·10	100	103 ,,
7	0·19	1·45	0·05	100	108 ,,
8	0·18	1·48	0·02	100	109 ,,
9	0·20	1·49	0·01	100	109 ,,
10	0·23	1·495	0·005	100	110 ,,
11	0·20	1·50	0·00	100	109 ,,
12	0·25	1·46	0·04*	100	110 ,,
13	0·24	1·48	0·02*	100	110 ,,
14	0·26	......Unprepared......			34 ,,

In all my experiments I considered the woods to be totally destroyed when it was impossible to withdraw them from the ground unbroken, and when they broke up with the slightest effort. It must be understood that, in making use of a similar process to judge of the degree of alteration of the wood, we cannot obtain very rigorous measurements, and that we must not attach very great importance to slight differences of observations.

On examining the foregoing table it is observed that—

1. Sulphate of iron possesses a certain antiseptic property, much weaker, however, than that of sulphate of copper.
2. Woods prepared with solutions containing at the same time sulphate of iron and sulphate of copper are preserved underground for almost the same period of time—at least when the sulphate of iron is in inconsiderable proportion.
3. There is no need to prefer chemically pure sulphate of copper to that of commerce.

M. Boucherie recently made some observations which are a contradiction to my results. According to him, sulphate of copper should not be used if it contain more than 5 or 6 per cent of sulphate of iron, and he considers it expedient to only use pure or properly purified cupric sulphate. Without pretending to settle the question, I will merely refer to the interesting experiments of Payen upon a very ancient wheel, discovered, some years ago, in the copper mines of San Domingo, in Portugal. This wheel, found in a perfect state of preservation after immersion for fourteen centuries in waters charged with sulphates of copper and iron, contained a very decided quantity of the sub-sulphates of these metals.

Secondly, a certain number of salts act injuriously upon woods prepared with copper.

If we plunge such wood into a solution of chloride of sodium, carbonate of sodium, or carbonate of potassium, and then examine these solutions at the end of a little while, a very notable quantity of copper is always found in them—copper which was formerly held by the wood.

This explains the failure of all endeavours to protect wood against the action of the sea by means of the copper salt. By reason of the salts held in the sea, the sulphate of copper is readily washed out of the wood. So long as the wood contains copper marine molluscs do not attack it, but when the greater part of the salt has been washed away the wood is rapidly invaded. This the following record of an experiment proves: the experiment was on a piece of prepared beech submitted to the action of sea-water for a certain time. A part of it was intact; the remainder was deeply perforated by the *Teredo*:—

	Sulphate of Copper.
2·5 grms. of wood taken, the intact portion contained..	0·01140 grm.
2·5 grms. of wood taken, the attacked portion contained	0·00015 ,,

Probably the rapid destruction experienced by prepared timber, when it is buried under tunnels or certain grounds, and notably in calcareous spots, may be attributed to an analogous action. It is indeed possible that waters which diffuse themselves into these grounds are charged with certain saline matters (bicarbonate of calcium, &c.), which, like sea-water, possess the property of washing out the copper salt.

Thirdly, like certain salts, the solutions of carbonic acid carry off the sulphate of copper.

About 3 grms. of chips, carefully prepared and washed, were treated for seven days with solutions of carbonic acid. Every time the solution was changed it was filtered and very carefully analysed. The total quantity of copper thus carried off was 0·0028 grm., calculated in the condition of sulphate. Under similar conditions pure water had no effect upon the sulphated wood.

Maxime Paulet, in his late work,* described a like experiment. "Take some sawdust of wood injected with sulphate of copper, wash it with water until cyanoferride of potassium does not sensibly show in the washings traces of copper salt. At that moment plunge the apparently exhausted sawdust into ordinary gaseous water,—that is to say, into water impregnated with carbonic acid. After a short time the water will become coppery. What has taken place? It is conjecturable that the oxide of copper, under the influence of an excess of carbonic acid, has been dissolved and carried away."

After having determined the action of carbonic acid and saline solutions, I endeavoured to ascertain if pure water exercises any dissolving property on the cupric combinations contained in prepared woods. For this purpose two experiments were carried out:—

1. In an open vessel filled with distilled water some prepared and washed chips were immersed. The vessel was covered with glass to prevent evaporation, and was left to itself for a long time. Each chip contained—

	Sulphate of Copper per Grm. of Wood.
At the beginning of experiment	0·0073 grm.
,, end of seven months..	0·0054 ,,
,, ,, thirteen months	0·0060 ,,
,, ,, about nineteen months..	0·0054 ,,

The action of water is thus manifest; but is it really due to the water? or may it be attributed to an accidental cause? for example, to the presence of carbonic acid dissolved in the water? Although we ought not to attach too much importance to an isolated experiment, we should not fail to notice that this supposition will explain the equality of the last three numbers.

2. I put into a glass globe some distilled water—water boiled for a certain time to drive away the greater portion of the gases dissolved in it. Some chips, prepared and carefully washed, were then introduced, and after a second boiling the globe was hermetically sealed, and left for a period of 200 days. At the end of that time I filtered the water, and found the quantity of metal dissolved in the liquid was 0·0002 grm., calculated in the condition of crystallised sulphate.

We ought not, even now, to rashly conclude that the action whereby even this small quantity of copper has been extracted is really the effect of the water. As before,

* Sulphates of copper of commerce.

* "Traité de la Conservation de Bois." Paris, 1874

carbonic acid may have been the cause, for we know that water, even after a very prolonged boiling, obstinately retains small quantities of gas: moreover, if the wood is not completely saturated with copper,—if even a very minute fragment of the wood does not take up the salt,—it may itself furnish a certain quantity of carbonic acid. Whatever it may be I think I may justly conclude, from my experiments, that if water does exercise any action upon prepared wood it is but a very slight one.

SINGULAR ELECTRIC PHENOMENON.

WE extract the following correspondence from the *Scientific American* :—

"An electric phenomenon has recently been observed which I am unable to account for, and I would be grateful if you will help me to an understanding of it.

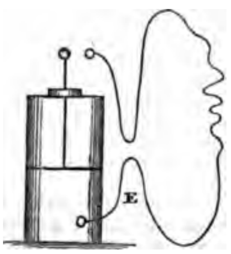
A house, built of limestone, stands upon a solid bed of the same material. Water is brought to it from a spring on the side of a neighbouring hill, across an intervening valley, and poured into a tank on the third floor. An overflow pipe leads from the tank to the barn. The pipe that supplies the kitchen leads from near the bottom of the tank, and is connected to the range and boiler in the usual manner. All the pipes are in contact with the wall, and are quite near each other. The hot and cold water pipes are connected at the boiler, and also between the cocks; but of course the pipe is plugged at this point with solder, as usual. During every thunderstorm of any magnitude, frequent and violent electrical discharges are noticed passing from one pipe to the other. The pipes are all iron, except at the connections to boiler and cocks, where lead is used. I would ascribe the excitement to thermal difference in the pipes, but they are so intimately connected that I cannot see how it is possible. Your opinion would be thankfully received.

THOMAS P. CONARD.

30th and Chestnut Streets, Philadelphia, Pa.

"In reference to the very interesting observation of Mr. Conard, on which you have asked my opinion, I would say that it is a striking illustration of a well-known principle of electricity, to which I have before had occasion to refer in your pages. There was at one time a very general impression that, if two routes of different facility were offered to an electric discharge, it would flow entirely by the better one. This, though (I think) still to be found stated in some text-books, is entirely untrue. On the contrary, the fact is that, if two or a hundred routes, differing in facility or conducting power, or, to use a technical expression, "of unequal resistances," are offered to the passage of an electric current or discharge, it will divide itself between them all, in direct proportion to their facility or conducting power.

Among other illustrations of this, I find in Ferguson's "Electricity," 1866, page 63, the following:—"A Leyden



jar being charged, we have a wire bent, as shown in the engraving, and armed with balls at the ends. One end of this being held against the outside of the jar and the other brought within striking distance of the knob, a spark will pass at E, where the two parts of the wire should be, say, ⅛th of an inch apart. This evidently is because while the wire is a far better conductor than the air, yet some of the discharge will even pass through the worst conductor; and the wire being long and the air-path short, the difference is not so great but that the fraction passing through the air is an appreciable quantity."

The general principle above stated is one which lies at the foundation of the whole subject of electrical measurements, in which such wonderful results have been reached of late years. Those of our readers who may wish for fuller information on this last subject we would refer to the article by the present writer on "Electricity," in Johnson's "Encyclopedia," or to Sabine's or Culley's works on the electric telegraph.

After what we have said above, it is hardly necessary to make any personal application to the case before us. No doubt Mr. Conard's tank is near his lightning-rod, or in some other way is plentifully supplied with electricity during a thunderstorm. This finds its way to the earth by countless routes—by the walls of the house to a very slight degree, by the various pipes in proportion to their conducting power; and, in the particular case noticed, it finds the hot-water pipe so far a desirable road to the copper boiler, and thence to the ground, that part of the current which enters the cold-water pipe takes that route. I think it likely that there are some joints on the cold-water pipe, between the spark plate and the boiler, cemented with red-lead, which is an excellent insulator, or other like body. This would not, however, be essential.

Assuming a difference in the tension of the pipes, through a difference of their ground connections, induction would exaggerate the same, and aid in this production of the spark; but while this and other actions may no doubt conspire to the effect, the first cause which we have described is, we believe, the main one.

HENRY MORTON.

Stevens Institute of Technology, Hoboken, N.J.

"Regarding the statements relating to the singular electric phenomena described on page 100 of your current volume, as being in some respects opposed to hitherto observed facts, I decided to investigate the case thoroughly, and ascertain in the first place what the facts were, and then see whether they were in accord with previous observations. For this purpose I sent one of my assistants to the house where the electrical displays occurred, furnished with the proper instruments for making careful and accurate measurements of the resistances of the rods, pipes, and other conductors about the premises.

The first measurement taken was to ascertain the resistance between the two pipes leading to and from the heater. This was found to be less than 0·01 of an ohm, and most of that was probably due to the connections of the galvanometer. Of course this proved conclusively that no sparks ever passed between these pipes, and Mr. Baldwin, the occupant of the house, said that the published statement was wrong in this regard.

The resistances of the supply pipe, overflow pipe, waste pipe, and lightning-rod were then measured, with the following results:—Resistance of the lightning-rod = 161 ohms; of waste pipe = 284 ohms; of overflow pipe = 15 ohms; of supply pipe = 0. The house stands on a hill on the dividing line of a slate and limestone formation, and the lightning-rod has been placed in the fissure of the rock to the depth of perhaps 6 or 7 feet, and is therefore partially insulated; and its normal resistance is doubtless much more than 161 ohms, which was found while everything was wet, a rainstorm having come up just before the tests were made. A resistance of 161 ohms in the lightning-rod, however, is sufficient, in my opinion, to occasion all the phenomena of discharge which have been observed during heavy storms. The supply pipe is

iron, and leads directly to a spring half a mile distant, where the best earth connection in the country is found. Owing to the insulating quality of the foundation upon which the house rests, the house constitutes one side of a leaky condenser, of which the slate and limestone form the dielectric, and the earth the opposite side. When a thunderstorm occurs the whole house is charged in a greater or less degree; and as the earth connection of the lightning-rod is insufficient to carry all the electricity which it receives, the electricity is discharged through every available channel, of which the supply pipe is the best. In light storms the phenomenon would not be noticed; it becomes very marked in heavy ones.

In this case the supply pipe was the safety-valve of the house. The proprietor of the house was advised to connect the lightning-rod to the supply pipe by a large copper wire, which will probably terminate the curious phenomena which have been observed.

I trust the time will soon come when lightning-rods will be erected by persons possessed of sufficient electrical education as to be able to tell whether they have a resistance of 161 ohms or of 0. Probably no important business at the present time is, as a rule, entrusted to a class of men so utterly ignorant of their duties as this one. In every case where a building supplied with a lightning-rod is destroyed by lightning, the parties who put up the lightning-rod ought to be prosecuted. A vigorous course of treatment of this sort would soon convince these people that a reasonable amount of study of the laws of electricity is necessary for their own safety as well as that of their patrons.

I wish that every electrical phenomenon which occurs could be promptly and carefully investigated by competent practical electricians. Why cannot the scientific departments of our colleges undertake this service? It would furnish a fund of accurate information which would prove of very great practical value.

GEORGE B. PRESCOTT.

New York City.

ON A NEW VERTICAL-LANTERN GALVANOMETER.*

By GEORGE F. BARKER, M.D.

DESIRING to show to a large audience some delicate experiments in magneto-electric induction, in a recent lecture upon the Gramme machine, a new form of demonstration galvanometer was devised for the purpose, which has answered the object so well that it seems desirable to make some permanent record of its construction.

Various plans have already been proposed for making visible to an audience the oscillations of a galvanometer needle; but they all seem to have certain inherent objections which have prevented them from coming into general use. Perhaps the most common of these devices is that first used by Gauss in 1827, and adopted subsequently by Poggendorff and by Weber, which consists in attaching a mirror to the needle. By this means a beam of light may be reflected to the zero point of a distant scale, and any deflection of the needle made clearly evident. The advantages of this method are: 1st, the motion of the needle may be indefinitely magnified by increasing the distance of the scale, and this without impairing the delicacy of the instrument; and 2nd, the angular deflection of the needle is doubled by the reflection. These unquestioned advantages have led to the adoption of this method of reading in the most excellent galvanometers of Sir William Thomson. While, therefore, for the purposes of research, this method seems to leave very little to be desired, yet for purposes of lecture demonstration it has never come into very great favour; perhaps because the adjustments are somewhst tedious to make, and because, when made, the motion to the right or left of a spot of light upon a screen fails of its full significance to an average audience.

Another plan is that used by Tyndall in the lectures which he gave in this country. In principle, it is identical with that employed in the megascope; *i.e.*, a graduated circle over which the needle moves, is strongly illuminated with the electric light, and then by means of a lens a magnified image of both circle and needle is formed on the creen. The insufficient illumination given in this way, and the somewhat awkward arrangement of the apparatus required, have prevented its general adoption. A much more satisfactory arrangement was described by Professor Mayer in 1872,* in which he appears to have made use of, for the first time, of the excellent so-called vertical lantern in galvanometry. Upon the horizontal plane face of the condensing lens of this vertical lantern, Mayer places a delicately balanced magnetic needle, and on each side of the lens, separated by a distance equal to its diameter, is a flat spiral of square copper wire, the axis of those spirals passing through the point of suspension of the needle. A graduated circle is drawn or photographed on the glass beneath the needle, and the image of this, together with that of the needle itself, is projected on the screen, enlarged to any desirable extent. The defect of this apparatus, so excellent in many respects, seems to have been its want of delicaey; for in the same paper the use of a flat narrow coil wound lengthwise about the needle, is recommended as better for thermal currents. Moreover, a year later, in 1873,† Mayer described another galvanometer improvement, entirely different in its character. In this latter instrument, the ordinary astatic galvanometer of Melloni was made use of, an inverted scale being drawn on the inside of the shade, in front of which traversed an index in the form of a small acute rhomb, attached to a balanced arm transverse to the axis of suspension of the needle, and moving with it. The seale and index were placed in front of the condensing lenses of an ordinary lantern, and their images were projected on the screen in the usual way by the use of the objective. This instrument is essentially the same in principle as the mirror-galvanometer; but it cannot be as sensitive as the latter, while it is open to the same objection which we have brought against this—the objection of unintelligibility. In the hands of so skilful an experimenter as Mayer, it seems, however, to have worked admirably well.

It was a tacit conviction, that none of the forms of apparatus now described would satisfactorily answer all the requirements of the lecture above referred to, that led to the devising of the galvanometer now to be described, which was constructed in February of the present year. Like the first galvanometer of Mayer, the vertical lantern as improved by Morton,‡ forms the basis of the apparatus. Parallel rays of light, from the lantern in front of which it is placed, are received upon the mirror, which is inclined 45° to the horizon, and are thrown directly upward, upon the horizontal plano-convex lens just above. These rays, converged by the lens, enter the object glass, and are thrown on the screen by the smaller inclined mirror placed above it. The upper face of the lens forms thus a horizontal table, upon which water-tanks, &c., may be placed, and many beautiful experiments shown. To adapt this vertical lantern to the purposes of a galvanometer, a graduated circle photo-

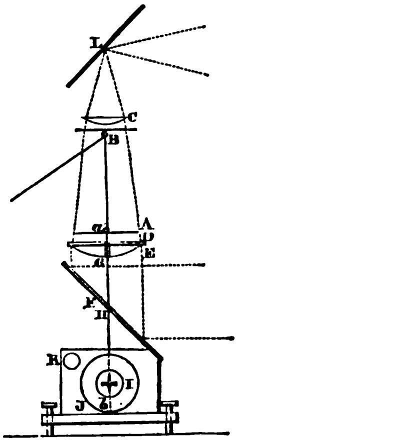
* Read before the American Philosophical Society.

* *Am. Journ. Sci.*, III., iii., 414, June, 1872; *Journ. Frank. Inst.*, III., lxiii., 421, June, 1872.

† *Am. Journ. Sci.*, III., v., 270, April, 1873.

‡ *Am. Journ. Sci.*, III., ii., 71, 153, July, August, 1871; *Journ. Frank. Inst.*, III, lxi., 300, May, 1871; *Quarterly Journal of Science*, October, 1871. In Duboscq's vertical attachment, which was advertised in his catalogue in 1870, the arrangement is similar, except that the beam received upon the mirror is a diverging one, and consequently the horizontal lens is of a shorter focus. A total reflection prism, placed above the object glass, throws the light to the screen. The instrument gives uniformly illuminated but not very bright light.

graphed on glass is placed upon the horizontal condensing lens. Above this, a magnetic needle, of the shade of a very acute rhomb, is suspended by a filament of silk, which passes up through a loop formed in a wire stretched close beneath the object glass, and thence down to the side pillar which supports this objective, where it is fastened by a bit of wax, to facilitate adjustment. The needle itself is fixed to an aluminum wire, which passes down through openings drilled in the scale glass, the horizontal lens, and the inclined mirror, and which carries a second needle near its lower end.* Surrounding this lower needle is a circular coil of wire, having a cylindrical hollow core an inch in diameter, in which the needle swings, and a smaller opening transverse to this, through which the suspension wire passes. In the apparatus already constructed (in which the upper needle is five centimetres long (the coil is composed of 100 feet of No. 14 copper wire, and has a resistance of 0·235 ohm. The accompanying cross section of the vertical-lantern galvanometer as at present arranged, drawn on a scale $\frac{1}{8}$, will serve to make the above description more clear. A is the needle, suspended directly above the scale-glass D, by a silk filament passing through the loop B, close under the objective C. This needle is attached to the aluminum wire *ab*, which passes directly through the scale-glass D, the condensing E, and the inclined mirror F, at H, and carries, near its lower end, the second needle I. This needle is shorter (its length is 2·2 c.m.) and heavier than the upper one, and



moves in the core of the circular coil J, whose ends connect with the screw-cups at K. This coil rests on the base of the lantern, enclosed in a suitable frame. It is obvious that when the instrument is so placed that the coil is in the plane of the meridian, any current passing through this coil will act on the lower needle, and, since both needles are attached to the same wire, both will be simultaneously and equally deflected. Upon the screen is seen only the graduated circle and the upper needle; all the other parts of the apparatus are either out of the field or out of focus. Moreover, the hole in the lens is covered by the middle portion of the needle, and hence is not visible. The size of the image is of course determined by the distance of the galvanometer from the screen; in class experiments, a circle eight feet in diameter is sufficient; though in the lecture above referred to, the circle was sixteen feet across, and the needle was fourteen feet long, the field being brilliant.

The method of construction which has now been described is evidently capable of producing a galvanometer for demonstration, whose delicacy may be determined at will, depending only on the kind of work to be done with it. In the first place the needles may be made more or less perfectly astatic and so freed more or less completely from the action of the earth's magnetism, and consequently more or less sensitive. Moreover, an astatic system seems to be preferable to one in which damping magnets are used, since it is freer from influence by local causes; though if desirable for a coarser class of experiments, the considerable distance which separates the needles in this instrument, allows the use of a damping magnet with either of them. In the galvanometer now in use, the upper needle is the stronger, and gives sufficient directive tendency to the system to bring the deflected needle back to zero quite promptly. In the experiments referred to below, the system made 25 oscillations per minute.

Secondly, the space beneath the mirror is sufficiently large to permit the use of a coil of any needed size. Since, therefore, the lower needle is entirely closed within the coil, the field of force within which it moves may be made sensibly equal at all angles of deflection, as in the galvanometers of Sir William Thomson. Hence the indication of the instrument may be made quantitative, at least within certain limits. The circular coil too, has decided advantages over the flat coil, since the mass of wire being nearer to the needle, produces a more intense field. Were it desirable, a double coil, containing an astatic combination, could be placed below the mirror, the upper needle in that case serving only as an index. The instrument above described has a coil three inches in diameter and one inch thick; the diameter of the core being one inch. Since its resistance is only about a quarter of an ohm, it is intended for use with circuits of small resistance, such as thermo-currents and the like.

The results of a few experiments made with this new vertical-lantern galvanometer will illustrate the working of the instrument and will demonstrate its delicacy. The apparatus used was not constructed especially for the purpose, but was a part of the University collection.

Induction Currents.—1. The galvanometer was connected with a coil of covered copper wire, No. 11 of the American wire gauge, about 10 centimetres long and 6 in diameter; having a resistance of 0·323 ohm. A small bar magnet 5 centimetres long and weighing 6½ grams, gave, when introduced into the coil, a deflection of 40°. On withdrawing the magnet, the needle moved 40° in the opposite direction.

2. A small coil, 20 c.m. long and 3·5 in diameter, made of No. 16 wire, and having a resistance of 0·371 ohm, through which the current of a Grenet battery exposing 4 square inches of zinc surface was passing, was introduced into the centre of a large wire coil, whose resistance was 0·295 ohm, connected with the galvanometer. The deflection produced was 20°. The same deflection was observed on making and breaking contact with the battery, the smaller coil remaining within the larger.

3. A coil of No. 14 copper wire, 60 c.m. in diameter, and containing about forty turns, the resistance of which was 0·85 ohm, was connected with the galvanometer, and placed on the floor. Raising the south side 6 inches caused a deflection of 4°. Placing the coil with its plane vertical, a movement of 2 c.m. to the right or left caused a deflection of 3°, and of 20 c.m. of 10°. A rotation of 90° gave a deflection of 12°, and one of 180° of 24°. These deflections were of course due to currents generated by the earth's magnetism.

Thermo-Currents.—4. Two pieces of No. 22 wire, 15 c.m. long, were taken, the one of copper, the other of iron wire, and united at one end by silver solder. On connecting the other ends to the galvanometer, the heat of the hand caused a deflection of the needle of 20°. ——

* After the new galvanometer was completed and had been in use for several weeks, I observed, in re-reading Mayer's first paper, a note stating that the idea had occurred to him of using an astatic combination consisting of two needles, one above the lens and the other below the inclined mirror, the two being connected by a stiff wire passing through holes in the condenser and the mirror. The plan of placing the coil round the lower needle does not seem to have suggested itself to him. Indeed, it does not appear that the arrangement he mentions was ever carried into practical effect.

5. A thermo-pile of 25 pairs, each of bismuth and antimony, was connected to the instrument. The heat from the hand placed at 5 c.m. distance caused a deflection of 3°.

6. Two cubes of boiling water acted differentially on the pile. At the distance of 5 c.m. the deflection was 20°; moving 1 to 10 c.m., the deflection was reduced to 5°.

Voltaic Current.—7. A drop of water was placed on a zinc plate. While one of the connecting copper wires touched the zinc, the other was made to touch the water. The deflection was 16°.

The claim which is here made for the instrument, however, is rather for the general principle of its construction than for the advantages possessed by the individual galvanometer above described, which was constructed at short notice to meet an emergency. The comparatively small cost for which it may be fitted to the vertical lantern, the readiness with which it may be brought into use, the brilliantly illuminated circle of light which it gives upon the screen, with its graduated circle and needle, the great range of delicacy which may be given to the instrument by varying the coil and needles so that all experimental requirements may be answered, and, finally, the satisfactory character of its performance as a demonstration galvanometer,—all combine to justify the record which is here made of it.

MECHANICAL AND ELECTRICAL TESTS OF IRON WIRE.

IN a recent number of the Journal* the results of a series of tests of different samples of iron wire were given. Since that time a number of additional samples have been tested in the same manner, and the results are given in the subjoined table. For convenience of comparison, the results given in the former table have also been included in this one, and one or two slight typographical errors corrected. An additional column, under the head of "Relative Breaking Strain," has been introduced, which has been calculated from the actual breaking strain as given in the fifth column, and the weight per mile as given in the second column, and shows the number of feet of its own length that each sample would be capable of sustaining. The arrangement of the table, it will be noticed, affords an opportunity of comparing in adjacent columns the relative breaking strain and relative conductivity of each sample. The tests are arranged in the order of their relative breaking strain.—*New York Journal of the Telegraph.*

NOTES.

THE iron telegraph poles in Persia are put to a novel use. A friend who has lately returned from that country informs us that between Teheran and Shiraz it is the common custom of the inhabitants to use the poles as targets for rifle shooting. Standing at one post and shooting at another, the people find the telegraph poles most convenient institutions for gun practice, and no doubt many believe that is their proper and legitimate use. The poles are made of sheet iron, and the natives test their guns by trying whether the bullet will pierce the post. Some posts are thus riddled with holes, and soon give way altogether. The reason why telegraph posts in Persia require frequent renewal is no longer a mystery.

The report of the Meteorological Committee of the Royal Society for 1874, issued on the 17th inst., contains the following information respecting weather telegraphy:—The office receives, or would receive, were the Continental telegraphic communication and that with the Shetlands perfect, fifty-one reports every morning, and nine every afternoon, except on Sundays. The observations are taken on Sundays as on other days, but are not received at the Meteorological Office until Monday morning, when the report for Sunday is made out. The stations are situate along the entire coast of the Continent, from Christiansund, in lat. 63 deg. N., to Corunna, in lat. 43 deg. N., with four stations on the coast of the Baltic

	Mechanical					Electrical.	
Sample Mark and Guage.	Weight per Mile (lbs.).	Per cent of Elongation.	No. of Twists (6 ins.).	Actual Breaking Strain (lbs.).	Relative Breaking Strain.	Per cent Conductivity Pure Copper = 100.	Resistance per mile in Ohms at 60° F.
EBB. Galv. No. 12	190·83	11·5	14, 16 } 15·0	430, 405 } 417·5	11552·2	14·4	30·50
EBB. Galv. No. 8	381·66	17·7	24, 29 } 26·5	945, 930 } 937·5	12930·6	17·3	12·67
EBB. Galv. No. 11	222·64	17·2	21, 22 } 21·5	575, 580 } 577·5	13639·4	15·6	24·20
151. No. 9½	282·80	10·0	25, 28 } 26·5	760, 780 } 770·0	14375·9	21·9	16·10
EBB. Galv. No. 10	254·44	17·7	28, 29 } 28·5	675, 720 } 697·5	14478·1	17·8	18·42
146. No. 9½	287·50	16·0	27, 31 } 29·0	825, 840 } 832·5	15288·86	21·9	16·10
EBB. Galv. No. 6	508·88	11·4	21, 22 } 21·5	1585, 1590 } 1587·5	16462·4	17·7	9·21
EBB. Galv. No. 9	318·05	19·3	17, 18 } 17·5	1005, 1010 } 1007·5	16725·1	16·9	15·54
Nashua " No. 8	381·65	15·1	25, 28 } 26·5	1530, 1540 } 1535·0	21183·0	14·7	15·00
MS. Plain. No. 6	528·00	10·4	18, 21 } 19·5	2110, 2165 } 2137·5	21375·0	13·5	11·78
443. No. 8	378·10	10·0	29, 33 } 31·0	1630, 1640 } 1635·0	22301·4	16·5	16·10
AH. No. 9½	293·50	16·0	27, 28 } 27·5	1255, 1260 } 1257·5	22635·0	15·1	22·70

* ELECTRICAL NEWS, vol. i., page 47.

and one at Cape Sicié in the Mediterranean. The system is, unfortunately, most defective along our own western coasts, owing to the imperfections of telegraphic communication in those thinly-peopled and mountainous districts. The only stations along the line in question are Valentia, Greencastle on Lough Foyle, Ardrossan, and Stornoway. The Committee are not without hopes that they may be able to carry out the idea, proposed in their last report, of establishing a station at Mullaghmore, a low-lying point on the south side of Donegal Bay, not far from Sligo. The possibility of deriving benefit as regards the probable weather of these islands from constant reports from America has frequently been inserted in the newspapers and scientific journals, but the experience of the Office, which for four years received daily reports free of charge from Heart's Content by the liberality of the Anglo-American Telegraph Company, is not favourable to the idea of incurring expense for such a service. Not only was little benefit derived from such isolated and unsupported reports, but the subsequent study of the weather recorded in ships' logs has shown that atmospheric disturbances, though they may cross the Atlantic occasionally from shore to shore, in most instances undergo such changes in their progress that the fact of the severity of a storm on the coast of America is no gauge of its probable character when it arrives on our shores. The daily observations are taken at 8 a.m., Greenwich time, and most of the telegrams arrive in London about 9 o'clock, when the Intelligence Department of the Post Office extracts from them the portions required for its wind and weather reports. They are then at once transmitted to the office by the private wire. About two hours are required for their reduction, discussion, and the preparation of the daily weather report, copies of which are ready by about 11 a.m., and are at once supplied for the afternoon issue of several of the London papers. A wind chart for the day is also drawn for the *Shipping Gazette*. A brief telegraphic *resumé* of the weather is despatched to the Marine Ministry in Paris, and, if necessary, telegraphic intelligence of storms or of atmospherical disturbance is sent to our own coasts and to foreign countries. Later in the day the foreign telegrams, and subsequently the afternoon reports, come in. The daily weather charts are drawn by noon, and forwarded to the lithographers to be printed. The copies for postal distribution are received at the Office at about 3.30 p.m. The total number of copies issued every day is about 530.

An important question as to the law of copyright in newspaper telegrams has lately been debated in the Melbourne Law Courts. The proprietors of the *Melbourne Argus* pay a large sum for the purpose of obtaining the latest telegrams from Europe. Any newspaper proprietors who may wish to publish the telegrams so obtained can do so by paying a contribution towards the expenses incurred. The proprietor of the *Gipps Land Mercury* made an agreement to pay for the right of publishing the telegrams. This agreement was carried out for several months, when the proprietor cancelled it. The European telegrams received by the *Argus* were, however, republished in another form, as from a Melbourne correspondent of the *Mercury* with the preliminary words "It is reported," or "The news about town is." This was considered a breach of the copyright which the proprietors of the *Argus* possessed in the telegrams, and as there was another newspaper at sale that did contribute towards the expenses of the receipt of the telegrams, a suit was instituted in the Equity Court to restrain the proprietor of the *Mercury* from republishing the telegrams. It was argued for the defendant that as the telegrams were matters of news, any one could re-publish them without breach of the Copyright Act. Mr. Justice Molesworth held, however, that the plaintiffs had a property in the telegrams, and that no one could re-publish them without the permission of the persons to whom they had been sent in the first instance. An injunction was therefore granted to restrain the defendant from publishing the telegrams.

COMMERCIAL NOTES.

The India-Rubber, Gutta-Percha, and Telegraph Works Company have received a telegram from Mr. Gray announcing the successful completion of the Iquique-Caldera section of their West Coast of South America cables. This places Peru in telegraphic communication with Europe.

The traffic receipts of the Anglo-American Telegraph Company on the 15th were £1020; on the 16th, £890; on the 17th, £790; on the 18th, £780; on the 19th, £270; on the 20th, £690; on the 21st to £880.

The report of the Direct Spanish Telegraph Company shows a balance of £6118, which, after payment of the dividend on the preference shares, will be sufficient to allow of a dividend on the ordinary shares at the rate of 4 per cent per annum, leaving the reserve fund standing at £1011.

TELEGRAPH SHARE LIST.

Amount per Share.	Name of Company.	Amount paid up.	Closing Quotations.
£		£	Sept. 22.
Stock	Anglo-American	100	62[illegible]—63[illegible]
10	Black Sea	All	2—4
10	Brazilian Submarine	All	6[illegible]—6[illegible]
10	Cuba	All	7[illegible]—[illegible]
10	Ditto, 10 per cent Preference ..	All	13[illegible]—14[illegible]
10	Direct Spanish	9	6—6[illegible]
10	Ditto, 10 per cent Preference ..	All	12—12[illegible]
20	Direct United States Cable	All	10[illegible]—11[illegible]
10	Eastern	All	7[illegible]—7[illegible]
..	Ditto, 6 per cent Debenture	..	10[illegible]—1[illegible]
10	Ditto, Exten. Australia and China	All	7[illegible]—7[illegible]
10	German Union Telegraph and Trust	All	7[illegible]—[illegible]
10	Globe Telegraph and Trust	All	5[illegible]—5[illegible]
10	Ditto, 6 per cent Preference	All	10—10[illegible]
10	Great Northern	All	9—9[illegible]
25	Indo-European	All	20—21
10	Mediterranean Extension	All	2[illegible]—3[illegible]
10	Ditto, 8 per cent Preference	All	9[illegible]—10[illegible]
10	Panama and South Pacific..	2[illegible]	..—..
8	Reuter's	All	10—10[illegible]
Stock	Submarine	100	190—200
1	Ditto, Scrip	All	1[illegible]—2
10	West India and Panama	All	2[illegible]—3
10	Ditto, 10 per cent Preference ..	All	11—[illegible]
20	Western and Brazilian	All	10[illegible]—11[illegible]
1000 dls.	Western Un. U.S. 7 per cent 1st M.B.	All	10[illegible]—[illegible]
100	Ditto, 6 per cent	All	90—9[illegible]
10	Hooper's Telegraph Works	All	3[illegible]—[illegible]
50	India-Rubber and Gutta-Percha ..	All	[illegible]—[illegible]
Cert.	Submarine Cables Trust	100	9[illegible]—9[illegible]
12	Telegraph Construction	All	21[illegible]—[illegible]
100	Ditto, 7 per cent Bonds	All	103—10[illegible]

PATENTS.

APPLICATIONS FOR LETTERS PATENT.

3096. Jean Maurice Emile Baudot, engineer, of Boulevard de Strasbourg, 23, Paris, for an invention of "Improved electric telegraph apparatus."—Dated September 3, 1875.

3187. Joseph Rogers, electrician, of Owens Row, Goswell Road, Middlesex, for an invention of "A new or improved galvanic shield or protector for imparting electricity to the chest and lungs and other parts of the human body."—Dated September 11, 1875.

3243. Edwin Powley Alexander, consulting engineer and patent agent, of 14, Southampton Buildings, Middlesex, for an invention of "Improvements in magneto-electric machines and in electromotive engines."——A communication to him from abroad by Emile Bürgin, engineer, of Paris, France.—Dated September 16, 1875.

GRANTS OF PROVISIONAL PROTECTION FOR SIX MONTHS.

2946. To Camille Alphonse Faure, of Trafalgar Square, Charing Cross, Westminster, for the invention of "Improvements in thermo-electric batteries and electro-motors.

2996. To Walter John Kilner, bachelor of medicine, of 104, Ladbroke Grove Road, Kensington, Middlesex, for the invention for "Producing a continuous current of electricity by means of a rotating magnet or magnets, in combination with or without an apparatus for regulating the tension of the current."

3096. To Jean Maurice Emile Baudot, engineer, of Boulevard de Strasbourg, 23, Paris, for the invention of "Improved electric telegraph apparatus."

NOTICES TO PROCEED.

2844. Sir James Anderson, Knight, of 66, Old Broad Street, London, Edward Bull, electrician, and George Oscar Spratt, both of Porthcurno, Cornwall, have given notice in respect of the invention of "Improvements in electric telegraph apparatus."

1719. Frederick William Ewen, manufacturer, of Manchester, Lancaster, and George Frederick James, machinist, of Salford, in the same county, have given notice in respect of the invention of "Improvements in insulating electric telegraph wires, and in machinery or apparatus for manufacturing the same."

PATENTS WHICH HAVE BECOME VOID,

By reason of the Non-payment of the additional Stamp Duty of £50, before the Expiration of the Third Year from the Date of such Patents.

2587. William Robert Lake, of the firm of Haseltine, Lake, and Co., patent agents, Southampton Buildings, London, for an invention of "Improvements in electrical apparatus for lighting gas and other burners."—A communication to him from abroad by Jacob Porter Tirrell, of Charlestown, and John Ware Flether and William Clark Cutler, all in Massachusetts, U.S.A.—Dated August 30, 1872.

LETTERS PATENT FOR INVENTIONS WHICH HAVE BECOME VOID,

By reason of the Non-payment of the additional Stamp Duty of £100, before the Expiration of the Seventh Year from the Date of such Patents.

2683. Cromwell Fleetwood Varley, of Beckenham, Kent, for an invention of "Improvements in electric telegraphs."—Dated August 29, 1868.

2735. Samuel Sharrock, engineer, of Liverpool, Lancaster, for an invention of "Improvements in metallic standards or posts for electric telegraphs and signal masts."—Dated September 4, 1868.

ABSTRACTS OF SPECIFICATIONS.

Improvements in the mode of controlling horses by the use of magnetic electricity. George Laycock, dyer, Whittington, Derby. March 4, 1875.—No. 805. To stop or retard the speed of horses by magneto electricity by means of a communication with a magnetic machine or galvanic battery, and passing a current through the mouth or different parts of the animal. Also to urge the animal to increased speed by similar means applied to different parts of the animal.

Improvements in the means of igniting gas and in apparatus employed therein. Marshall Arthur Wier, 33, Abchurch Lane, London. March 4, 1875.—No. 806. The invention consists in the employment of a magneto-electric machine for generating the current of electricity for igniting gas at the burners of railway carriage-lamps, street-lamps, &c.; also in an arrangement of contact breaker connected to the regulating cock of each burner by which, on opening the said regulating cock, the contact is broken and a spark allowed to pass igniting the gas; whilst, when the regulating cock is closed or turned into certain other positions, the contact breaker remains closed, and the current passes through it without emitting a spark.

PATENTS GRANTED IN FOREIGN STATES.

Belgium.

37,610. D. Rousseau, for an imported invention of improvements in electric signals."—Dated August 9, 1875.—(English patent, August 4, 1875.)

37,622. A. de Gaulne and C. Mildé, jun., for an imported invention of "An electric fire-alarm knob."—Dated August 10, 1875.—(French patent, March 31, 1875.)

37,655. E. J. Gondolo, for an imported invention of "Improvements in electric clocks."—Dated August 14, 1875.—(French patent, April 20, 1875.)

37,663. A. Luyssen, of Furnes, for "Telegraph-poles of wrought- or cast-iron."—Dated August 16, 1875.

37,669. A. Billet, for an imported invention of "An automatic regulator for telegraphic apparatus."—Dated August 16, 1875.—(French patent, August 13, 1875.)

United States.

165,156. *Automatic Telegraphs.* — Patrick B. Delany, Jersey City, N.J.—The combination with an automatic transmitter of a relay which connects the line on one movement of its armature to the signalling battery, and upon the other to the earth or to a reversing battery, substantially as and for the purposes set forth.

165,157. *Telegraph Relays.*—Patrick B. Delany, Jersey City, N.J.—The combination with a fixed armature, plain or electro-magnetic, of an electro-magnetic coil, movably suspended above the same, substantially as herein shown and described.

165,183. *Electric Signal Apparatus for Steam Vessels.*—Charles A. Stearns, Boston, Mass., assignor to himself, Wm. H. Torbert, Philadelphia, Pa., and Edmund B. Vannerar and C. H. Dolbear, Boston, Mass.—The shaft or other moving part of the machinery has a stud affixed to it, which operates upon a circuit closing apparatus, so arranged that one circuit is closed when the shaft moves in one direction, and the other circuit when in the other. An indicator is placed at any distance to show the direction, which will also show the rapidity of the revolution. The combination of the shaft E, projection F, bent levers D D', sliding bars A A', plates *m m' n n'*, battery M B, circuits *w w'*, and indicators I I', substantially as and for the purpose set forth.

165,396. *Electric Winding Mechanisms for Clock Work.*—John William Wignall, Manchester, Great Britain.—Running down of motor allows battery plates to lower into liquid, sending current around magnets, operating, when charged, to wind up the motor and withdraw plates. The combination in a clock operated by a weight, of an armature, *k*, of an electro-magnet, connected to the shaft of the winding-drum with mechanism, substantially as

described, for putting the battery into and out of action, as for the purpose set forth.

165,210. *Galvanic Batteries.* Joseph C. Clamond and L. A. Gaiffe, Paris, France. Filed November 6, 1874.—An artificial carbon is produced by calcining a mixture of graphite, tar, and sugar. The carbon thus prepared is immersed in a solution of perchloride of iron or of another salt of sesquioxide of iron, and then in ammonia. The sesquioxide of iron is precipitated and incorporated in the pores of the carbon. By this means the porous vessel is dispensed with, and the depolarising agent is chemically produced in the pores of the carbon itself. 1. The improved sesquioxide of iron battery, containing sesquioxide of iron in combination with zinc and an ammoniacal salt, as specified. 2. The method herein described of preparing a sesquioxide of iron battery by mixing sesquioxide of iron with coke, or fixing it in the pores of carbon, substantially as specified.

165,263. *Duplex Telegraphs.* G. Smith, Astoria, N.Y. Filed December 22, 1874.—1. The two batteries *a* and *b* of unequal power, connected with the same poles to the line, in combination with the adjustable rheostat between the larger battery and the line, the receiving instrument between the smaller battery and the line, and the key for simultaneously opening and closing the circuits from both batteries, substantially as specified. 2. In a duplex telegraph the arrangement of the batteries *a* and *b*, receiving instrument *f*, and rheostat, substantially as specified, so that the batteries shall neutralise each other at the receiving instrument and act together on the line, substantially as set forth.

165,281. *Circuit Closers for Railway Signals.* Saml. Weeks, New Orleans, La. Filed June 5, 1875. A circuit closing device for signalling the passage of railway trains over the track, composed of a spring-supported connecting plate insulated from the ground, and placed in communication with the line wires, and of a central contact plate supported below the connector, and connected to the earth for closing the circuit with the station by the contact of connector and central plate, substantially in the manner and for the purpose set forth.

165,312. *Poles for Galvanic Batteries.* H. P. Dechett, New York, N.Y. Filed June 26, 1874.—A battery pole, consisting of a conducting skeleton or perforated frame or jacket, containing broken carbon or a carbon plate, substantially as and for the purpose described.

165,379. *Printing Telegraphs.* John E. Smith, New York, N.Y. Filed May 21, 1875.—Type wheel revolved both on make and break of circuit. One coil of printing magnets in a local circuit closed by escapement lever on prolonged closure of main circuit, other in a local ditto on prolonged breaking. Unison applied to stop transmitter automatically at zero. 1. In a printing telegraph the arrangement of one-half or portion of the wire of the printing magnets in one local circuit or branch of a local circuit, and the other half or portion of the wire of said magnets in another local circuit or branch of a local circuit, in combination with a circuit breaker that acts, during the rotation of the type wheel, to open and close the circuit or circuits alternately through the two parts of the printing magnet, substantially as set forth. 2. In a printing telegraph, a printing magnet in a local circuit or circuits, a type wheel magnet in a main circuit, and an escapement wheel that allows the type wheel to advance a whole character at a single movement of the escapement pallet, in combination with a lever that serves the double purpose of liberating the type wheel and closing the local printing circuit, to effect an impression by either a prolonged opening or closing of the main circuit. 3. In a printing telegraph, the ratchet wheel *l* and the pawl *m*, in combination with the lever *f*, substantially as described. 4. The springs *c* and *e*, in combination with an electro-magnet and a train of wheels for letting into an electric circuit a resistance either measurable or infinite. 5. The magnet C, pallet B, springs *c* and *e*, resistance *k*, lever *f*, ratchet wheel *l*, and pawl *m*, in combination with a train of wheels, substantially as set forth. 6. In the transmitter of a printing telegraph, the combination with a train of wheels of the arm P, and the loosely-fitted lever E, substantially as and for the purposes set forth. 7. The lever U in combination with the lever R, substantially as set forth. 8. In printing telegraph apparatus, a self-locking transmitter, in combination with a self-locking printer.

165,413. *Electric Thermostats.* Edwd. J. Frost, Philadelphia, Pa., assignor of one-half his right to J. Hoehnlen, same place. Filed December 24, 1874.—1. The thermostat consisting of a compound strip formed into a flat spiral, a central adjusting screw, and the casing or covering, substantially as set forth. 2. The combination, with the spiral compound strip and central adjusting screw, of the index plate and index concealed in a hollow in the base of the thermostat.

165,452. *Galvanic Batteries.* George L. Leclanché, Paris, France, assignor to H. L. Roosevelt. Filed December 16, 1874.—Incorporates the depolarising substance with the negative element in the manner specified in claims, thus dispensing with the use of a porous cup. 1. A galvanic battery in which the use of a porous cup is dispensed with, and in which an insoluble or slightly soluble depolarising substance, as above defined, rendered solid (with or without cement, by pressure), is combined with a conductor and negative pole, substantially as and for the purposes set forth. 2. A depolarising body for connection with the negative pole of a galvanic battery, consisting, in whole or in part, of an insoluble or slightly soluble depolarising substance, rendered solid, with or without cement, by pressure in a mould, substantially as and for the purposes set forth. 3. A galvanic battery in which the use of a porous cup or diaphragm, or its equivalent, is dispensed with, and in which the negative element consists of a mixture of an insoluble or slightly soluble depolarising substance, as hereinbefore defined, and a conductor, with or without cement, rendered solid by pressure, substantially as and for the purposes set forth. 4. A negative element for a galvanic battery, consisting, in whole or in part, of a mixture of insoluble or slightly soluble depolarising substance, as above defined, and a conductor with or without cement, rendered solid by pressure in a mould, substantially as and for the purposes set forth.

165,535. *Underground Telegraph Lines.* David Brooks, Philadelphia, Pa. Filed June 2, 1875.—1. An underground telegraph wire or cable clothed with absorbent material, covered with insulating substance, and contained within a pipe, in combination with a liquid insulating medium maintained under pressure within the said pipe, all substantially as set forth. 2. An underground telegraph wire or cable surrounded by pipes arranged in sections, each section being bent upward at the ends, as set forth, and terminating in a box or receptacle, B, for the purpose specified.

TO CORRESPONDENTS.

*** Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which "The Electrical News and Telegraphic Reporter" is the organ, will always command attention. Literary communications and books for review should be addressed to the Editor; business communications to the Publisher, Boy Court, Ludgate Hill, London, E.C.

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London: Printed and Published by the Proprietor, William Crookes, at the Office Boy Court, Ludgate Hill, E.C. September 23, 1875.

THE

ELECTRICAL NEWS

AND

TELEGRAPHIC REPORTER.

[Edited by Wm. Crookes, F.R.S., &c.] [Registered for Transmission Abroad.

Vol. 1.—No. 14.] Thursday, September 30, 1875. [PRICE, 4d. POST FREE, 4½d.

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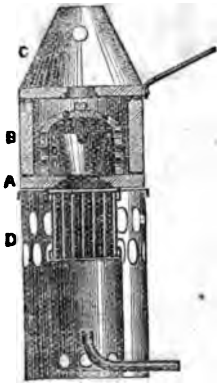

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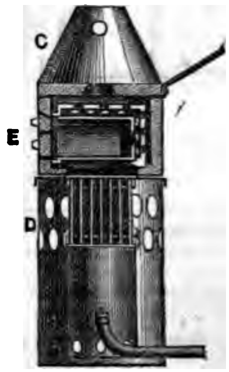

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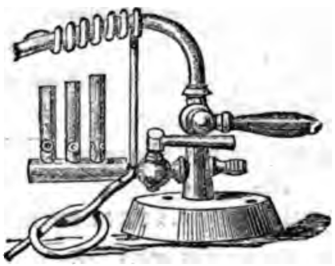

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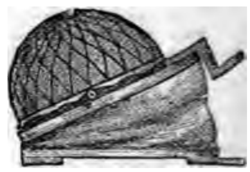

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THE ELECTRICAL NEWS.

VOL. I. No. 14.

THE ELECTRIC CONDUCTIVITY OF MINERAL SUBSTANCES.*

By the Count Th. du MONCEL,
Membre de l'Institut de France.

(Concluded from page 155.)

THE influence of temperature is also very manifest, and it *results always in annulling or lessening the conductivity of minerals.* However, the manner in which this influence is exercised upon hard and soft stones, is not entirely the same. With the latter the weakening or annulling of conductivity which heat accomplishes principally results from a simple drying of the damp layer covering the sides of the pores; whilst in hard stones heat physically augments their resistance as is the case with metals. The consequence is that, is these latter stones, conductivity, after having been destroyed by a suitable and prolonged heating, is restorable much more promptly than in soft stones—especially if they are retained in a rather dry and warm apartment. With some of them conductivity cannot even be destroyed after being "stoved" for a quarter of an hour. Thus Heronville flint, whose resistance represents 2032 kilometres for a deflection of 78° at a temperature of 20°,† having undergone the operation, furnished, though still burning hot, a deflection of 35° with the circuit unshunted. Certainly this deflection was far from being constant: it had some oscillation at certain moments as low as zero. But at the end of fifteen minutes the upward tendency of the reading commenced, and arrived at almost its normal condition after the space of four hours.

With porous stones the time necessary to resume a commencement of conductivity may exceed eight hours, although during a damp season only four hours may be required. But the progress of this conductivity in a rather dry apartment is extremely slow; for after the lapse of several days, and after removing the electrodes, one is scarcely able to re-obtain the abnormal deflections. This conductivity, in the case of my Caen stone sample, from seven o'clock to midnight on a very damp evening, with the circuit unshunted, only varied from 12° to 22°, and on the morrow it was still only 59°.

As moisture increases with a lowering of temperature, and since the two combined influence an increase of conductivity in the different stones, it happens that hard stones like porous ones are susceptible of large fluctuations (during different hours of the day) in the strength of the current which crosses them; especially when they are exposed to the outside air and particularly to the sun. In the one the conductivity increases or diminishes principally according to moisture variations; in the other temperature variations have the most energetic influence. In my note of October 5, 1874, I gave an indication of these fluctuations for Caen stone, flint, serpentine, and hard cystis when exposed to the outer air. I have this year obtained some analogous results from the yellow jaspery flint which figures in the table,‡ and which has given the following deflections when exposed during clear and dry weather:—84° at mid-day, 81° at 3 p.m., 73° at 4 p.m., 68° at 5 p.m., 73° at 6.30 p.m., 79° at 9 p.m., and 81° at midnight.

It now remains for me to refer to the manner in which a current traversing a stone becomes impressed by the persistent polarisation which is found developed within it in consequence of a prior electrification. One of the most manifest effects of the reaction which is then produced is the successive weakening of the current's strength when several consecutive "closings" of the circuit are effected in one direction, even after the indications of polarisation currents which have preceded them are cancelled from the galvanometer. With certain minerals, particularly porous stones, this weakening is so considerable that in certain cases the current can no longer pass; and in order to make it reappear, it becomes necessary to dismount the electrodes and wipe the stone. When the direction of the current across the stone is reversed, and several "closings" are then accomplished in the same direction, some very different effects may be brought about according to the nature of the minerals, their homogeneity, the degree of persistency of molecular polarisation, and the greater or less duration of the circuit "closings" or intervals of times between the "closings." Generally the first inverse current is weaker for the first moment than those which have preceded it; and those which follow it become stronger either really, or relatively, to what they ought to be. At other times the reverse takes precedence; but even then it is only after a certain period of the current's action that the strengthening takes place. The first of these effects is perfectly characterised in hard stones, and the second is often met with in soft stones. In every case we may recognise therefrom that polarisation in stones is chiefly an electro-static one; for if it were a chemical polarisation the resulting inverse current should always reinforce the currents transmitted at the moment of their inversion. Here are three very interesting examples of these descriptions of reactions; one relating to hard stones, the other two to soft stones. The Nos. refer to the order of the experiments. (See Table on next page).

In the first example the two "closings" in the same direction successively diminished the strength of the current; but, *after the inversion*, the first current, which was very weak in relation to those which preceded it, *became, on the contrary, reinforced by the second closure;* and the same is the case after the second inversion. In the second and third experiments the currents are strengthened after the first inversion; and this reinforcement, which diminishes in the case of the Caen stone on the second closure, increases, however, with the American stone.

If we turn over in our minds the different effects which I have pointed out, and endeavour to attribute them to the effects of electrification as propounded for the last fifteen years, we shall soon convince ourselves that they are not so simple; and that these latter themselves somewhat participate, at least for certain dielectrics, in the reactions so clearly observable in minerals.

The first deduction that may be drawn from my experiments is, indeed, that minerals (like the generality of indifferently conducting bodies susceptible of being affected by damp air) *possess two kinds of conductivities.* One conductivity is *electrotonic*, connected with the matter itself, of which these bodies are composed; the other is *electrostatic*, referable to the moist layer which covers the sides of the porous interstices by which moisture has penetrated. Hence we may be allowed to conclude that the secondary effects, consequent upon these two classes of conductivity, should clash within the minerals; and as they possess a *very different electrostatic capacity—since their absorption faculty for the atmosphere's moisture is itself variable according to their nature and molecular texture*—it happens that with some of them—and hard stones are among the number—electrotonic conductivity dominates; whilst with others electrolytic conductivity prevails. It may even happen that certain stones possess these two conductivities in an equal degree. Now what are the effects which, from a theoretic point of view, should arise in these different cases?

It is essential first of all to explain even the manner in

* Communicated by the Author.

† This deflection in simple circuit corresponds to a resistance of 375,495 kilometres of telegraph wire.

‡ See ELECTRICAL NEWS, page 153.

No.	Principal Current. At the Beginning.	Principal Current. Five Minutes After.	Polarisation Current. At the Beginning.	No.	Principal Current Reversed. At the Beginning.	Principal Current Reversed. Five Minutes After.	Polarisation Current. At the Beginning.
	Heronville Flint (with shunt of 2 kilometres).						
1.	(38°—34°)	32°	(90°—77°)	3.	(28°—23°)	25°	(90°—75°)
2.	(32—28)	30	(90—80)	4.	(36—27)	29	(90—84)
5.	(31—22)	25	(90—75)				
6.	(36—29)	31	(90—83)				
	Caen Stone (with shunt of 64 kilometres).						
1.	(90—64)	51	(44—17)	3.	(78—50)	52	(30—16)
2.	(54—47)	32	(43—20)	4.	(63—46)	42	(33—19)
	American (with shunt of 64 kilometres).						
1.	(90—83)	74	(48—17)	3.	(90—69)	77	(28—17)
2.	(89—58)	52	(36—20)	4.	(90—85)	77	(44—18)

which the phenomenon of electrification is produced; and to ascertain whether the electrostatic reaction, which (in the electrification theory) always precedes transmission across the material, exists really and truly in my own experiments.

When an electric current goes through a high resistance conductor, its strength after a certain variable time—variable according to the resistance—becomes almost permanent, provided, however, that the source is constant, and that it does not produce any secondary action. With aërial insulated metallic conductors this variable period is of short duration, and cannot be detected without special instruments; but when, as with stones, resistances are called into question which may attain several millions of kilometres, it necessarily becomes visible, and the movement of the galvanometer's needle is very slow. Generally this is not the case. The moment the circuit is closed *the deflection immediately attains a maximum, then the needle poises itself at a distance more or less great from the maximum point; and it is then that it commences to ascend or descend in a successive and regular manner.*

Sometimes even the first deflection subsists alone, and the needle, having attained a position rarely exceeding 10°, slowly returns to zero. This takes place with crystallised stones, amethyst, Iceland spar, gypsum, &c., and certain jaspers. Since in these conditions the electric transmission has not followed its ordinary course, we must premise that it has been preceded by a peculiar electric action giving rise to an electric movement; and this action can only be that of a charge current resulting from an immediate polarisation of the molecules of the dielectric in contact with the metallic electrodes which bind up the stone to the circuit. This electrostatic effect, however, cannot give rise to a continuous charge current; for, once charged to the potential of the source, the electrified molecules determine a static condition in the metallic circuit. This condition, nevertheless, may be broken in upon and so give place to a new current if the molecular polarisation, in reacting gradually by means of successive electrical decompositions and recompositions, provoke an electric flow across the substance. Now this is precisely what does take place, and is what constitutes *electrotonic* transmission, of which I have already spoken. On the other hand, if we suppose that by reason of bad conductivity the successive neutralisations are slowly effected, the molecules of the dielectric adjacent to those which are in contact with the metallic electrodes would acquire an excess charge whose potential tends unceasingly to increase, and which, therefore, not being able to easily disperse because of bad conductivity, creates this persistent electrostatic charge of which I have already proved the existence, and which occasions the secondary currents of so long a duration in Heronville flint. When a flitting deflection takes place, as has been the case in certain experiments about which I have already spoken, it is evidently occasioned by the electrostatic charge. It is wrong, however, to conclude from this that the electrotonic current does not exist: on some mirror galvanometers, with more developed electrodes and a stronger electric source, it will indubitably be found. The English, in fact, have thoroughly verified it in india-rubber and gutta-percha. Still it may be readily apprehended that the existence of this current is not indispensable to the production of that electrostatic effect which determines the needle's movement.

After what has been just stated, we understand without difficulty how the penetration of the electrostatic polarisation into the heart of the dielectric is at once the function of its electrostatic capacity and of its resistance. It is generally admitted that one of these properties is in inverse ratio of the other, but I think that for minerals this law is not general. Whatever it may be, as this polarisation is successive and persistent, it must react upon the transmitted current and indicate upon the galvanometer effects opposed to the different phases of transmission. (1). During the first moment the charge current *ought to persist for some instants in becoming weak* by reason of the successive penetration and the less to less energetic electrostatic action. (2). The current transmitted electrotonically in passing through all the phases of a variable period—always very long with dielectrics—should augment more and more in proportion as this variable period approaches to the permanent period, and especially in proportion as molecular polarisation penetrates deeper into the substance.

According to this theory, if minerals had only an electrotonic conductivity, the strength of the current transmitted through them should always increase after a first lowering. This happens, as has been seen, for a great number of hard stones; but as they possess, in addition, an electrolytic conductivity resulting from the absorption of moisture from the atmosphere, there is combined with the electrostatic polarisation effects an electro-chemical polarisation which produces a gradual and continual drop in the strength of the transmitted current. When this effect has less energy than that determined by electrostatic action, a successive strengthening of the transmitted current becomes manifest; and the molecular polarisation induced by the electrostatic charge gives place to a more or less energetic and durable polarisation current. Its durability is proportional to the electrostatic capacity of the mineral, and the depth to which the polarising action has penetrated: a depth which depends on the conductivity of the mineral, on the duration of the electric action, and on the strength of the current. When, on the contrary, the electro-chemical action dominates, as is often found in soft and porous stones, the transmitted current always continues to diminish; and the polarising current, whilst it is generally less energetic than in the preceding case, lasts, at the same time, for a relatively shorter period. Lastly, the two kinds of polarisation are nearly equal in energy, the current becomes nearly stable after first submitting to a drop (the result of the two actions), and no polarisation current can arise. In fact, the persistent negative polarities (determined by electrostatic action upon the stone's

molecules, which yield to the influence of the negative electrode) are neutralised by the positive polarities which are provoked upon this electrode by electro-chemical polarisation; that is to say by the deposit of hydrogen bubbles upon the negative electrode: the same sort of action may be said of the other electrode. This is precisely what takes place with china red onyx, gun flint, serpentine, &c., &c. Let us suppose, now, any portion of the stone positive with regard to another portion in consequence of its non-homogeneous texture, or because it will less readily absorb moisture; we immediately comprehend the accidental differences which may be brought about regarding the conditions of conductivity of the transmitted current according as they are sent in one or the other direction.

As to the reactions produced on currents by the persistent polarisation of the dielectric molecules, they are easily understood as far as homogeneous minerals are concerned; and they are with ease accounted for, as shown by the table already given. Molecular polarisation being persistent, the charge current from each current closure (in the same direction) should be less and less energetic, since on the one hand the differences of the potentials between the electric source and the stone particles most directly influenced by the electrostatic action, is less and less considerable, whilst on the other side electro-chemical polarisation tends to oppose itself to each charge. Hence results the successive drop of the transmitted current when several "closings" of the current in one direction are effected, and that, too, after the disappearance of the resulting polarisation current.

When, after these successive closings, we reverse the direction of the current, the remanent polarities necessarily oppose a certain resistance to the inverse electrostatic action, and ought to provoke at the beginning a lowering in the strength of the current—provided, however, that electro-chemical polarisation is not predominant. But this inverse polarity successively continuing to grow less, fresh electrostatic effects, acquire more and more a greater power, and furnish relatively an increase in the current's strength until they are themselves diminished by new developed polarities. This may be noticed from the figures in my last table referring to Heronville flint. Yet when electro-chemical prevails over electrostatic polarisation, the contrary must take place, for then the polarisation current which has a tendency to be created will be found in the direction of the new transmitted current. It will still be remarked that this effect is not generally produced, and that only when the circuit remains closed for a certain while in the same direction, or is at least closed twice in succession. After a single closure the polarising chemical action is not sufficiently developed, especially when the closure is of short duration. A rather curious effect is produced in this latter case after a certain number of experiments. The deflections which are manifested at the beginning (for the direction of the current corresponding to the weakest deflections) become weak much less quickly than corresponding deflections from the reversed current. This shows that the initial deflections are especially impressed by electrostatic polarisation. This may be judged of from the following list of experiments made upon the Caen stone sample, and with current closures of two minutes only—the inversions of the current succeeding one another without interruption.

As may be seen, all—even the most contradictory—effects readily explain themselves with the theory I have just expounded, without admitting any hypothesis. It is a theory entirely based upon facts, and I could even say that the persistence of molecular polarisation after the disappearance of the galvanometer deflections—persistence upon which this theory is supported, and from which we may deduce effects produced ulteriorly—may be even directly shown. To do so it suffices to break the circuit which unites the stone directly to the galvanometer, and to after re-establish it as it was before. The needle is then observed to swerve under the influence of the

No.	Commencement.	After One Minute.	After Two Minutes.	No.	Inversions. Commencement.	After One Minute.	After Two Minutes.
1	90°	71°	67°	2	90°	64°	55°
3	90	64	61	4	90	60	47
5	90	60	56	6	90	49	37
7	90	56	50	8	90	43	30
9	88	51	45	10	90	37	26
11	85	49	40	12	90	33	22
13	80	46	37	14	88	30	19
15	75	44	35	16	83	27	18
17	73	43	31	18	78	25	17
19	72	41	29	20	74	24	16

remanent polarities, and to maintain its deviation for some moments. I have refound these small currents a long while after electrification of the stones; but a heating process caused them to instantly disperse.

THE ACTION OF CHARCOAL IN BATTERIES.

By H. SAUVAGE.

Grove, in 1839, first constructed his batteries with graphite for interior negative electrodes. Bunsen, in 1843, proposing this electrode "as an economical improvement," surrounded the porous pot and the zinc with coke-dust and oily coal calcined in moulds. Archereau, in 1849, returning to Grove's arrangement, obtained with charcoal a higher potential than from Bunsen's elements of greater surface; and Liais and Fleury (reviving in 1852 the Bunsen arrangement), by substituting for the agglomerated carbon a carbon sufficiently porous to allow the acid to percolate, maintained the high potential of Archereau's elements with a less surface of zinc though a larger one of the carbon. These facts seem to firmly demonstrate that the employment of charcoal as a negative electrode is advantageous from the twofold view of economy and conductivity, and that it is advisable to increase its surface.

It does not seem as though we should assign any very special action to the carbon. Like copper, platinum, or any other electro-negative body, it plays no other part in the voltaic economy than that of a simple conductor, to share the electric condition of the liquid and communicate it to the exterior circuit. As with all other negative electrodes, we aim at developing its surface, and preserving it from the hydrogen bubbles which cover it with an injurious insulating layer, whereby an adverse and weakening current is set up.

Now, in the numerous systems with which it is proposed to chemically absorb the hydrogen before its arrival at the negative electrode—whether by a second liquid, by a damp doughy mixture, by a solid oxide, by a layer of sand, or by pulverised carbon—it is worthy of remark that the carbon plate is always found confined in the liquid, the sand, paste, or in a pot more or less hermetically closed. Leclanché himself, in his battery (manganese and pounded charcoal), does not indicate any other use for the orifice which he makes in the wax stopper of his porous pots than to allow the passage of the air when the pot is immersed into the battery liquid.

The carbon has nearly always been placed under very disadvantageous conditions for manifesting and preserving its action, if any such it has. That it has such an action is maintained by certain *savants*, among whom is the Count Du Moncel, who says—"Even charcoal will develop an electromotive force acting in concert with that produced from the oxidation of the zinc." If, therefore, it has a favourable action towards the development of the electromotive force of the couple of which it forms a part,

it can only be exercised, and continued, by eliminating the polarisation to which it is liable from certain conditions perhaps ill-observed until now.

Here are some experiments which appear to determine these conditions, and some observations regarding the possible *rôle* of the carbon when these conditions are realised. These experiments, which require more patience and time than science, are, however, very easily repeated and verified.

Three vessels of water containing a solution of sal-ammoniac being each divided into two compartments by a simple wooden partition, and the compartment of the lead negative electrode being filled with pounded carbon, a deflection of 17° was obtained, with a circuit of 50 kilos., when one-third of the carbon grains were out of the liquid. Without breaking the circuit, the deflection fell in four hours to 10° by covering the carbon with water; and the former deflection of 17° was restored on pumping out the water to its former height. Each repeated trial showed the current to be weakened by immersion of the carbon, and strengthened by the carbon's exposure to the air.

This remark explains the cause of the prompt failing of certain battery elements; for example, Gaiffe's medical boxes and Trouvé's closed-case batteries. It establishes the principle that the chief condition to observe in the use of carbon is to allow its *respiration* in the air. The word "respiration" seems well suited, for it is not sufficient, in order that the carbon exert its whole action, to enable it freely to give out the hydrogen absorbed; it must also take back air. This is proved by the following experiment, made with 4 elements on the Leclanché model, without manganese, and with porous pots furnished with bent waste pipes to receive the gas under water. Circuit was closed (without exterior resistance) for several days; then 50 kiloms. resistance was inserted, and the galvanometer's deflection observed. When the tubes were open the deflection rose in ten minutes from 2° to 14°, and in one hour and five minutes to 19°. In another similar trial, at 17·5° the upward movement remained stationary from the simple fact of the immersion of the waste tubes—the absorbed gas being disengaged, but air not being able to re-enter the carbon. If, after fourteen hours' suspension of upward motion, the tubes be opened to the air, the motion will be resumed until the normal deflection is reached. So long as air does not enter into the carbon, the disengaged gas is pure hydrogen; otherwise, as will be seen further on, it is carbonated hydrogen. It is thus essential in using carbon to let it have large access to air.

Nevertheless, the surface or the volume of the carbon does not apparently influence the development of electromotive force, from a given limit, but solely influences the absorption and disengagement of hydrogen. Thus 29 elements—formed of common salt water, carbon plates, and zinc wires, 5 m.m. diameter—gave, with 200 kiloms. resistance, 19° deflection, which fell to 8° with circuit closed for one hour. Some pounded charcoal was placed around the carbon plates, and separated from the zincs by wooden strips. The deflection was again 19° at the commencement, but it only fell to 15°, at which it was continued.

It is thus evidently useful to maintain a convenient proportion between the absorbing volume and the quantity of hydrogen liberated by the oxidation of the zinc.

The interior resistance for porous pots of weak capacity augments with the quantity of zinc oxidised, and consequently with the number of elements added. A group of 2 elements, having about 80 c.c. of charcoal, maintained, in a closed circuit of 50 kiloms. resistance, a deflection of 15° for forty days: the zinc electrodes were wires of 0·01 m. or 0·001 m. diameter, and, enclosed in gutta-percha sheaths, they only touched the liquid by their lower section. The waste of the zinc was close upon 0·01 grm. per hour.

It becomes probable that the strength of a battery of this class being given, we may, by progressively increasing the carbon, suppress polarisation. With an insufficient volume of carbon we cannot exceed a limited number of couples without increasing the resistance of the system until an almost complete stoppage of action is reached. This takes place with small porous pots of a capacity of 7 c.c.

Preserve the carbon from every chance of becoming dirty, or from every deposit capable of retarding absorption. Choose a carbon at the same time porous and hard; facilitate respiration into the air by providing a surface equal to that of absorption; and increase these surfaces proportionally to the required strength. Such are the conditions necessary to be observed in constructing negative electrodes of this character.

In order to render conspicuous the part that carbon performs in each system, the charcoal system has been compared with those of Marié-Davy, Bréguet, and Leclanché: the charcoal batteries were in each case of the same dimensions as those with which they were compared.

Bréguet's battery, described by the Count Du Moncel under the name of "Fortin battery of sal-ammoniac and pulverised carbon," having a prism of carbon surrounded with coke or pounded charcoal for the negative electrode, will well serve as the type of carbon batteries, if, instead of pulverised coke, only pounded charcoal be used. The zinc electrode is reduced to its useful surface, and the porous pot of large diameter overtowers by a half of its height the portion immersed; but, such as it is, notwithstanding its dimensions (at least four times as great as the elements prepared with charcoal, with which it has been compared), it is greatly inferior, and its inferiority is attributable only to the difference in the carbon used.

Compared by a sine galvanometer with 200 kiloms. exterior resistance, Bréguet's 12 elements at Louviers gave 24°, and the 12 similar elements at Hondouville gave 27°; 12 small charcoal elements gave 36°, and 12 of Marié-Davy's elements on this latter model gave 41·5°.

Compared again—dimensions being equal—with the same exterior resistance, with charcoal elements having no other exciting liquor than common salt water, 35 of Bréguet's elements of pounded coke, *without dust*, gave 22°, whilst the 35 charcoal elements *with water acidulated with common table salt*, as above described, gave 23°. The number of elements in this case had thus the effect of diminishing the strength by reason of the insufficient volume of the carbon.

The battery left on short circuit for one night, the pounded coke elements showed a deflection of 4° with 200 kiloms. of exterior resistance, and only went up to 8° at the end of three hours and a half. The charcoal elements first gave 8°, then 13° after three minutes only: the former elements never went higher than 8°, but went down to 7°; the latter maintained 13° and 14°. After a rest the coke elements only gave 15°, the charcoal elements 20°. We thus see how far preferable it is to make use of charcoal.

In the above experiment the dimensions of the cells were disadvantageous to the two systems; for, as the figures below indicate, the more we increase the number of these *small* elements the more we increase the battery resistance—the volume of carbon being no longer in suitable proportion to the quantity of hydrogen liberated by the zinc oxidation, and the retarded absorption opposing the proper "trim" of the liquid molecules.

Some elements on the small Marié-Davy pattern were also used to compare the carbon system with the amalgam depolarising system. Some carbon elements were set up with sal-ammoniac at the ratio of 10 to 20 grms. per element. Here are the results of comparative experiments with these two kinds of batteries of 25 elements each (the same galvanometer and exterior resistance as before):—From the 14th to the 23rd of August, 1872, the reading from the charcoal elements rose from 20° to 24°, whilst the Marié-Davy elements fell from 34° to 29°: the carbon

element was thus worth [illegible], or 0·84 of the Marié-Davy element. On the 23 of October the former gave 19°, and the second 22°, the proportion being still [illegible], or 0·88.

Left on closed circuit with 200 kiloms. for five minutes, the carbon battery descended from 19° to 13°, at which the reading was maintained; the sulphate of mercury battery stopped at 15°, the proportion being still 0·87.

Under these conditions, unfavourable to the carbon system, consequent upon the polarisation of the lead fastening insufficiently protected from the air (for, after six months' use, hydrated chloride of lead was found), the carbon battery has a strength equal to 1·19 of a large size Daniell, whilst the Marié-Davy elements are 1·37, and small size charcoal elements 1·15. The two systems have shown the same constancy, and both present the same peculiarity of resistance, increasing with the number of elements. After the information given by the Administration, the charcoal system—re-established under more favourable surface and fastening conditions—has been compared with the Leclanché system, to ascertain in a direct manner whether manganese is useful or not in it, and how far.

Here are the results of these researches, which it will be easy to verify and complete by applying them to a number of larger elements:—The two groups absolutely differed merely by the presence of peroxide of manganese in the Leclanché group, and perhaps by the greater or lesser hardness of the carbon. A battery of 5 Leclanché elements fell from 39° to 30° on the ordinary galvanometer, with a closed circuit of 50 kilometres resistance, in three hours and 20 minutes, which will represent, according to M. Bergon, about 14 hours of continuous telegraphic transmission. It was after this first period of the action of the binoxide of manganese that it was agreed upon to compare the Leclanché element with the charcoal element; the object being to determine if the former does not really owe to the carbon the action which it afterwards retains, or whether a portion of it is not due to the sesquioxide of manganese. Experiment proves that the two bodies are useless.

In anterior trials it had been too hastily concluded that the Leclanché element, after the reduction in the beginning, is absolutely only equivalent to one without manganese, because the porous pots of the carbon elements had been left open. These experiments were re-executed, care being taken this time to observe (for both systems) the same conditions of sealing up the porous pots; and it has been ascertained that during the whole period of the experiment, *i.e.*, until all the zincs are used up, the presence of the manganese does give a certain continuous advantage. At the beginning it gave to a group of 5 Leclanché elements 30° upon a galvanometer of 50 kilometres circuit, whilst the group of 5 elements of carbon only gave 28°. For a 72 hours closed circuit, the first maintained 29°, the second 27°.

Apart from this sensible superiority, the two groups were equally constant, and gave on a closed circuit the same polarisation results. Thus after working 80 hours with 50 kilometres, and 52 hours without exterior resistance (crystals only showing themselves in the state of fine needles on the porous pots), the resistance was restored to 50 kilometres, and the carbon group ran up from 22° to 27° in four minutes; the Leclanché group rose from 23° to 27° in the same time. When the crystals covered the pots, the two groups did not return to their normal strength until a long time had elapsed.

Likewise, before the deposit of the crystals on the pots, he waste tubes, sealed into the orifice of the wax stoppers, and plunged into the water, disengage the gases immediately in sensibly equal times in equal quantities. When the crystals cover the pots and zincs, the waste pipes commence to absorb water. The water mounts them to a great height, and then the gas drives it out in order to disengage itself. With elements of four couples the disengagement commences and terminates through the tube of the positive element in the Leclanché group, and through that of the negative element in the simple carbon group. This, which would appear to be connected with the fact that the pots of these two elements are much less charged with crystals, may depend upon the nature of the pots, but it will be interesting to certify if it continues to shows itself.

The experiment quoted higher up, and in which the resumption of the normal strength remains suspended by the immersion of the waste tubes, is reproduced in the two systems: it would appear to establish that the re-entry of air is as useful to the action of the carbon as to the manganese.

To resume, the two systems behave alike when both are sealed according to Leclanché's method, that is to say without any other communication with the air than through a narrow opening; but they maintain to the end an advantage of 2° (with 50 kilometres) in favour of manganese for groups of 5 elements. On the contrary, by opening the porous pots of the simple carbon elements, they obtain themselves this advantage of 2°, so that they are then equivalent to the *sealed* Leclanché elements; besides, the formation of crystals is considerably retarded, and the resumption of energy after a closed circuit is also considerably hastened. Lastly, the porous pots of the Leclanché elements being open in their turn, we obtain the following comparisons with groups of two elements:—

Open to the air	Leclanché elements	6·8°
	Simple carbon elements ..	6·0°
Sealed up ..	Leclanché elements	6·0°
	Simple carbon elements ..	5·25°

The ratio of the strengths in each case is 1·138; and i may be remarked (1) that the *sealed* Leclanché element is not of greater value than the *open* simple carbon one; (2) the presence of manganese increases the electromotive force of a charcoal element from 13 to 14 per cent; (3) by opening the Leclanché pots, its elements will in like manner gain 13 to 14 per cent. in electromotive force.

If from all these observations it turns out that manganese, although reduced to protoxide or sesquioxide, always remains useful, it does not seem less probable that the carbon has itself an action equally dependent on the return of air in order to become revived. There will in such a case be in the carbon some other property than its condensing or absorbing faculty, which, according to some, will of itself provoke a contrary electric disengagement.

In the hope of discovering some indications of the mode of action of the carbon and air in the differences of crystals and the gases liberated by the two systems, the analysis of these products was confided to M. Edward Ferray, chemist, at Evreux. He finds that the crystals which accumulate in both systems on the pots and zincs are a definite compound of chloride of zinc, ammonia, and crystallisation water; that the chloride of zinc is in an anhydrous condition although generated in the very midst of the liquid. This will be a consequence, possibly special to carbon batteries, of the chemical reactions exercised upon the chlorides, which are dissolved in the liquid, by the hydrogen absorbed by the carbon and carried across the polarised liquid when the sealing of the porous pots prevents its liberation. M. Ferray traces indeed in these crystals a salt of the special formula—

$$3ZnCl,4AzH_3,4HO$$

possessing the physical property of becoming decomposed in the presence of water according to the formula—

$$3ZnCl,4AzH_3,4HO = 3AzH_4Cl + AzH_4O + 3ZnO.$$

He considers this as the type of a series of analogous salts formed by carbon batteries.

The analysis of the gases has given a result worthy of attention, which, whilst proving that the carbon has a real action upon the hydrogen, will determine and limit at the same time the efficacy of manganese in Leclanché batteries after the reduction of the binoxide:—(1.) After a pro-

longed closed circuit, when the air of the carbon is expelled and the strength of the current is least, both the two systems disengage pure hydrogen, the deflection being the same in both cases. (2.) On the contrary, at the commencement of the action, that is to say under the ordinary conditions of telegraph work, there is a characteristic difference between the two gases: that which is evolved from the Leclanché element contains—

$\frac{1}{2}$ volume of hydrogen
$\frac{1}{2}$ " nitrogen and carbonic acid,

but from the simple carbon element the proportion is—

$\frac{1}{2}$ volume of hydrogen
$\frac{1}{3}$ " nitrogen and carbonic acid
$\frac{1}{6}$ " carbonated hydrogen.

According to these data, of two-thirds of hydrogen liberated by the battery, the Leclanché element only disengages half as pure hydrogen whilst the simple carbon element gives up $\frac{1}{2}$ volume of pure hydrogen and $\frac{1}{6}$ volume as carbonated hydrogen. Is not this equivalent to saying that the same proportion of hydrogen liberated by the battery in activity will be oxidised in the manganese cell, and carburetted in the simple carbon cell?

Definitively, the principal point which appears as the outcome of these observations is the necessity of giving to the negative electrodes of carbon a *respiration* surface into the air equal to that of absorption, and to increase these surfaces in the ratio of the required potential.—*Annales Telegraphiques.*

ON A METHOD OF

DETERMINING THE CONDUCTIVITY OF LIQUIDS FOR ELECTRICITY.

"While the electric conductivity of metals," says Dr. Oberbeck in a brochure recently published, "has been determined by numerous and accurate experiments, which have already led to the discovery of some remarkable laws (*e.g.*, the agreement in conductivity for electricity and heat), the conductivity of liquids which are chemically decomposed by the electric current has been accurately determined only in a few cases. The reason of this lies, no doubt, chiefly in the greater difficulty of the problem, but not in any less interest attaching to the passage of electricity through decomposable liquids. An exact knowledge of the phenomenon rather promises an enrichment of our knowledge in various ways, inasmuch as it is likely to prove important, both for the theory of the electric current and for a knowledge of the physical properties of liquids, as also in regard to the process of chemical decomposition. The first basis for the study of these phenomena is a comprehensive determination of the conductivity of the most different liquids. Precisely this, however, as already indicated, is involved in a number of experimental difficulties; and only recently have the defects in former methods been successfully remedied and trustworthy results afforded. But these results apply only to a small number of comparatively good conducting liquids, and exclusively to solutions of acids and salts in water. Apart from the fact that the data thus obtained are still far too few to warrant theoretical deductions, it may be observed that the liquids examined are of complex composition, consisting at least of two chemical compounds. One may, therefore, suppose that it would have been better to commence the investigation with the most simple compounds; for example, with pure water. When, however, it comes to be inquired why the conductivity of water has not been adequately determined, it will be remembered that this is very small, so that the methods hitherto employed could have led to no satisfactory results. The same holds good, in a greater degree, for other liquids, as, *e.g.*, alcohol and ether, which conduct electricity still worse than water. It was, therefore desired to find some new mode of determination which might be applicable to liquids that were bad conductors, and so serve to supplement the methods already known."

Dr. Oberbeck then describes the way in which he has attempted a solution of the problem.

If the ends of the induction spiral of an ordinary induction apparatus be metallically connected with the balls of a spark micrometer, then, with a determinate strength of the inducing current, there will be found a particular separation of the balls, with which a continuous stream of sparks still passes, whereas, if the distance be slightly increased, all passage of sparks will cease. If, now, an additional, or branch line, without interruption, be connected with the two ends of the induction spiral, the induced electricity will have two paths open to it; and it will depend on the intensity of the induction current, and the resistance of the branch line, whether sparks will still pass between the balls. If the branch line consist of metallic wire of no very considerable length, the stream of sparks will disappear, and will not recur, though the balls are brought ever so close together again. If, however, it consist of badly-conducting liquids in narrow tubes, a slight approximation of the micrometer balls will suffice to renew the stream of sparks. These experiments, easily repeated, may serve for measuring and comparing the conductivity of different liquids.

For a determinate strength of the inducing current (always controlled with a tangent compass) the spark-length of the induction current is ascertained with the aid of the spark micrometer. Then the liquid to be examined, enclosed in a long and thin glass tube, is placed in connection with the poles of the induction apparatus, and the (now diminished) extent of spark is determined; (understanding by extent of spark the separation between the balls at which a continuous stream of sparks still passes, whereas a slight increase of the separation makes the stream disappear). If the length of the liquid column be now changed, the extent of spark is also altered. In this way is obtained a series of corresponding spark-lengths, and lengths of liquid. Another liquid affords a similar series. To determine, next, the ratio of the conductivities of the two liquids, the two series of observations are represented graphically, the lengths of liquid being taken as abscissæ, and the corresponding spark-lengths as ordinates. Continuous curves are thus obtained, which mostly approximate to parabolas in form. From these curves, again, are ascertained the lengths of those columns of liquid which correspond to equal extents of spark. Assuming that equal extents of spark (in the sense explained) indicate equal resistances in the branch line, then, with equal sections, the lengths of the liquid columns must stand in the same relation as the conductivities.

This assumption forms the basis of the whole method, and Dr. Oberbeck seeks to show that it is justified.

He investigated, by the method described, the conductivity of various liquids, and communicates some of his results. To understand the figures, it is explained, that for avoidance of very small fractions, the "specific resistance" is given, instead of the converted value of the conductivity; and this "specific resistance" is referred to the resistance of a concentrated neutral solution of blue vitriol taken as unity.

It was desirable, then, first to determine the specific resistance of pure water. Accordingly, the author examined several specimens of distilled water bought at different times; but he obtained a series of values differing not inconsiderably from one another; showing that the conductivity of water is affected (increased) very notably by even the least impurities. In particular, where there is prolonged contact with the glass sides, a small quantity of the glass appears to pass into solution. From the values obtained may be deduced the resistance of that kind of water which has served as solvent for a series of

salts. The number for this was found to be 390. "I observe, however," says Dr. Oberbeck, "that with other kinds of water, resistances were found more than five times as great, so that, by repeated careful distillation, it would probably be possible to increase the specific resistance of the water considerably." In proof of the above assertion that small admixtures notably diminish the resistance of water, the following may be taken:—Distilled water with $\frac{1}{10}$ per cent of common salt, gave the resistance 54; the same, with $\frac{1}{10}$ per cent sal ammoniac, the resistance 40. Thus the conductivity was increased, in the former case, more than sevenfold, and in the latter nearly tenfold. A mixture of the two salt solutions in equal proportion gave the resistance 47, the arithmetic mean of the resistances of the constituents.

The specific resistances of alcohol, ether, and sulphide of carbon, were also examined. That of alcohol was 13 000, that of ether 40,000; the conduction of sulphide of carbon was still worse. After the specific resistances of alcohol and water were obtained, the question arose, in what way they might be lessened by additions of the same quantity of the same salt. Some of the resistances obtained give the following table:—

Water 390.		*Alcohol* 13,000.	
Water $+\frac{1}{10}$ p.ct. CdB_2	: 52	Alcohol $+\frac{1}{10}$ p.ct. CdB_2	: 1090
" $+\frac{1}{10}$ " $CuCl_2$	: 30	" $+\frac{1}{10}$ " $CuCl_2$	: 243
" $+5$ " $CuCl_2$	: 1	" $+5$ " $CuCl_2$	: 25

From this it appears—

(1). That every salt dissolved in a liquid increases the conductivity, in a quantitative way peculiar to it.

(2). That the solvent itself has still considerable influence on the conductivity of the solution.

For more extended deductions in this field of research, further observations are necessary.

THE QUEENSLAND TELEGRAPHS.

The Report on the Condition of the Electric Telegraphs of Queensland for the year ending 13th June, 1875, shows that, under the active superintendence of Mr. Cracknell, considerable progress has been made. At the time of writing the Report there were 3678 miles of line, 4975 miles of wire, 97 stations, and 210 officers. At the corresponding period of 1874 there were only 3203 miles of line, 3931 miles of wire, 74 stations, and 181 officers. The subjoined table shows the yearly progress since the opening of the line:—

Meteorological and shipping reports have been forwarded free of charge; but as the shipping telegrams seem only to benefit ship-owners and agents, Mr. Cracknell recommends that they should in future be placed on the same footing as ordinary business, and charged for at current rates.

The several lines in Queensland have worked well during the year. North of Rockhampton communication was, however, suspended for some days in February and March this year, during the prevalence of a cyclone. The line was seriously injured at Alligator Creek, near Yaamba, where the water rose 60 feet above its ordinary level, and submerged the wires.

During 1874 the cash collections of the Department, at all its branches, amounted to £21,396 6s. 6d.; value of messages transmitted on Her Majesty's Service, £7039 19s. 10d.; total revenue for the year, £28,436 6s. 4d. The expenditure was, for salaries, £23,272 0s. 3d.; contingencies, £11,796 16s. 10d.; refundments to other colonies, £2033 1s. 4d.; total, £37,101 18s. 5d.—showing that the expenditure exceeded the revenue by £8665 12s. 1d.

Out of 88 stations, the revenue exceeded the expenditure at 10 only: these are—Brisbane, Rockhampton, Townsville, Maryborough, Toowoomba, Mackay, Stanthorpe, Ravenswood, Millchester, and Charters Towers.

In 1873 the tariff of 1s. per ten words, exclusive of address and signature, with 1d. for every additional word, was adopted; the intercolonial rates were also lowered; and to this cause Mr. Cracknell attributes the unsatisfactory condition of the financial department. He considers that the adoption of a low uniform tariff on the long lines of the colony is premature. It is, however, a question whether or not the actual money loss is compensated by the collateral advantages derived from the Service.

The International business dealt with by Queensland Stations is very small, owing to the high tariff, no reduction having been made in the rates since the line was opened. Only 395 messages were transmitted and received during 1874, being an increase of 55 on the previous year.

Regulations for the examinations of candidates were issued in June, 1874. Eight examinations have since been held, at which forty-four candidates presented themselves: of these twenty-five passed, twenty of whom have received appointments, and five are in the learner's room. There are twelve junior operators in the Department, receiving salary at the rate of £100 per annum, who will be entitled to an increase of £20 per annum when they pass the examination.

Table showing Progress of Telegraph Department, Year by Year, from 1861 to 1874.

Year.	Miles of Line.	Miles of Wire.	No. of Stations.	No. of Officers.	Total No. of Messages transmitted.	Gross Receipts, Cash.			"O.H.M.S." Business.			Approximate of Free Business, Shipping, &c.			Gross Expenditure.			Population.
						£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	
1861	169½	169½	7	13	5,678	938	14	9	122	12	2	—			1,652	5	6	34,367
1862	169½	169½	7	18	16,833	3,724	10	0	701	12	10	—			3,560	13	4	45,077
1863	221	221	8	21	19,219	4,152	1	10	945	6	8	—			5,662	13	0	61,640
1864	298	298	11	25	27,246	5,713	3	10	1405	5	7	—			6,604	12	1	74,036
1865	1042	1131½	25	52	47,697	10,343	9	5	3039	2	5	—			12,226	14	11	87,775
1866	1476	1565	33	66	55,610	11,120	4	3	4158	10	5	—			14,001	1	1	96,172
1867	1663	1752¼	33	66	56,143	10,985	2	6	4459	3	8	—			15,382	6	11	99,849
1868	1722	1811¼	35	69	59,632	11,256	7	1	5791	0	2	—			15,601	9	5	107,427
1869	2039	2182¾	41	74	70,112	11,634	19	10	6776	11	7	—			16,100	12	8	109,897
1870	2132	2221½	43	78	81,483	11,774	16	8	5424	6	6	9000	0	0	17,121	9	9	115,567
1871	2525	2614¼	51	91	82,630	11,691	12	10	3956	2	6	9000	0	0	19,073	17	11	125,146
1872	2818	3368	59	122	121,998	18,794	7	3	5094	11	11	9000	0	0	24,081	3	9	133,553
1873	3059½	3609½	73	150	156,268	20,759	1	3	6386	12	0	9000	0	0	27,776	8	5	146,690
1874	3616¾	4891½	90	201	311,019	21,276	19	0	7039	19	10	9000	0	0	35,068	17	1	163,507

The cost of constructing the new lines has been somewhat greater than in former years, which Mr. Cracknell attributes to the enhanced price of material, scarcity of suitable labour, dearness of provisions, and also to the prosperous state of the Colony.

We learn from the Report that Wheatstone's automatic instruments, arranged for the duplex principle, have been introduced by the New South Wales Department, for the purpose of increasing the capacity of their Intercolonial lines.

SOLAR TELEGRAPHY.

It is a matter of common observation that the rays of the sun are brilliantly reflected to enormous distances from glass buildiings or from polished surfaces. Take, for instance, the Crystal Palace as a familiar illustration; the sun's rays, falling upon the ridged roof at a suitable angle, are reflected many miles away and are clearly visible even when the building is only dimly discernible through miles of intervening smoky atmosphere. Considering this, it might appear somewhat remarkable that advantage has not been taken of the circumstance to found a system of telegraphy thereon. Not that such a system could always be relied upon for use in this and other climates where sunlight is capricious. But in countries where sunshine is not so fitful such a system would serve the most useful purposes. As a matter of fact, the rays of the sun have been utilised for signalling purposes at intervals for centuries past. The fleet of Alexander the Great is said to have been guided along the Persian Gulf by mirrors on his return from invading India. On the North American prairies, too, the Indians still carry on signalling by means of sun flashes, and a similar method was adopted by the Russians at the siege of Sebastopol. But the principle appears never to have been reduced to a system; arbitrary signs have been and still are used; and no attempt seems to have been hitherto made to work out a perfect code of signals and to devise an instrument or apparatus which shall represent them.

Sun-flashing has, however, been of essential service in our Ordnance Survey, although even there it was only made to convey very limited information—to signal only, in fact, and not to converse. Towards the close of the last century General Roy was engaged in connecting the meridians of Paris and Greenwich, and he employed sun-flashing in his operations. Later on, in the early years of our Trigonometrical Survey, Bengal lights or Argand lamps were burned at night on the distant points the bearings of which it was desired to take. But this gave a very limited range and involved other practical difficulties, which led to the invention by Captain Drummond, R.E., of the light which bears his name. This enabled ranges of from 30 to 40 miles to be obtained, but even these distances were soon exceeded when, in 1822, Colonel Colby, R.E., who was then in charge of the survey, designed an apparatus for signalling by flashing the sun's rays, which proved very successful. Subsequently Captain Drummond improved upon Colonel Colby's instrument by the invention known as the heliostat, which was an instrument consisting of an adjustable mirror as a reflector, worked in connection with a combination of telescopes. This apparatus, at first somewhat complex, was afterwards greatly simplified. Professor Gauss, who was at this time conducting the survey at Hanover, also introduced a similar instrument, which proved of great service in facilitating the work. The heliostat is now a recognised adjunct of all trigonometrical surveys, and by its aid triangles having sides over 100 miles in length have been formed even in Great Britain—notably that formed by Sea Fell in Cumberland, Slieve Donard in Ireland, and Snowdon in Wales, the sides of which are respectively 111, 108, and 102 miles in length.

But the heliostat does no more than permit of an arbitrary set of signals being exchanged; it does not allow a conversation to be carried on. To bring the beams of the sun into subjection in this respect and to utilise them as a means of freely interchanging ideas was left for Mr. Henry C. Mance, of the Government Persian Gulf Telegraph Department, to accomplish.* This he has succeeded in effecting by means of a very simple apparatus which is known as the Mance Heliograph, or sun-telegragh, the construction of which we have lately had an opportunity of examining at the chambers of Mr. S. Goode, 5, Gray's-inn Square, that gentleman representing Mr. Mance in this country. The heliograph consists in the first place of a light tripod stand about 4ft. long when folded up for transport. On this tripod is screwed a circular mirror, varying in diameter according to the purpose for which the instrument is designed; that is whether for field or fixed observations. If for the former purpose the mirror is about 4in. in diameter; while if for the latter it is about 9 inches. The mirror is hung in a frame so as to revolve about a horizontal axis, and it is adjusted to the required angle of incidence with the sun by means of a telescopic connecting rod having a screw adjustment, the top end being attached to the upper edge of the mirror at the back. The horizontal circular traverse of the instrument is obtained by means of a tangent screw gearing into a small horizontal worm-wheel, with the centre of which the mirror is connected. By means of the tangent screw and the vertical screwed rod, the rays of the sun can be made to fall upon any given point with the utmost precision. The vertical rod behind the mirror is pivoted at the bottom to a lever, the fulcrum of which is on the horizontal worm-wheel, the lever constantly pressing against the lower end of the rod by means of a spring which is placed under it. It will thus be seen that when the rod is depressed it will depress the top edge of the mirror and draw it slightly backwards, the bottom edge being at the same time slightly raised and thrown forwards. In adjusting the instrument to commence signalling, the rays are directed to a point slightly below the distant observer's level, but upon depressing the connecting rod—for which purpose there is a small finger-piece attached to it—the flash is raised to the level of the observer, and he sees it. If now the lengths of these flashes be varied and grouped, they can be made to represent letters, and so words composing messages can be spelt out. This is precisely what Mr. Mance has done, and by adopting the Morse system of dashes and dots he is able on a fine day to make himself understood by an observer many miles off, as easily as one electric telegraph operator makes himself intelligible to another.

In adjusting the instrument for use, a light wooden rod having two brass sliding sights upon it, is employed. This is set up in the ground in front of the instrument, and the operator looks through a small space in the centre of the mirror, from which the quicksilver has been removed, towards the station with which he desires to communicate. The upper sight on the rod is then moved vertically until the centre of the mirror, the sight, and the distant station are truly aligned. Hence when the flash from the mirror is directed on to the sight it is in true line with the distant station, and can be seen by the observer there. This will, of course, be whenever the angle of the mirror is raised; when depressed, or in its normal position, the flash rests upon a cross piece on the rod, and, according as the sun's horizontal and vertical motions cause the flash to deviate from the true line, the signaller is able to see and to correct the error by means of the adjustments on the instrument. The observer at the distant station having seen the bright star-like appearances, sets his instrument to the point at which they appear, and acknowledges the fact, and the parties being thus placed in communication, the interchange of messages proceeds upon the system we have mentioned—namely, the Morse alphabet.

There are other details to which it is not necessary to refer here further than to observe that they consist in arrangements for signalling with the sun behind the apparatus by means of a reflector; for signalling at night, and for signalling either from fixed or variable positions. It is, however, an important fact that the apparatus has been in use for some time in India, where its working has been attended with every success, the range of the signals being very great and their intelligibility absolute. Official reports are very explicit in both these respects, and fully establish the capabilities of the heliograph. They state that the signals given are perfectly clear and satisfactory, and the

* See letter in The Electrical News, vol. i., p. 69.

they can be easily read in ordinary weather without telescopes up to 50 miles. Captain Collette, D.A.Q.M.G., certifies that under favourable conditions messages can be signalled up to 80 or even 100 miles without recourse being had to telescopes. The heliograph has the recommendations of economy in first cost and portability, as it weighs complete about 5 lbs., and packs up into a very small compass.

Subsequently to examining into the construction of the heliograph we were afforded an opportunity of witnessing its practical working by Mr. Goode. Taking advantage of the sunshine on Monday, Sept. 27, Mr. Goode stationed himself on the dome of St. Paul's, having previously despatched an electric telegraph operator to the Crystal Palace, where he stationed himself with a heliograph in the gallery of the North Tower. Mr. Goode had a telegraphic operator with him, and there was also present Mr. Sanders, of the Eastern Telegraph Company, who are arranging for the application of the system from Gibraltar across the Straits to Ceuta, in Morocco, thus bringing that country into telegraphic communication with Europe. The weather was not very propitious, the sky being at times overcast, while during the operations a heavy storm cloud was observed to drift over Sydenham. The two operators, moreover, had not previously seen the apparatus and made no arrangement previously to setting to work as to their course of procedure. Nevertheless, the instruments were duly sighted, and a series of brilliant flashes of light from the Palace tower indicated that those from St. Paul's had been seen. Signals in long and short flashes were freely interchanged as the intervals of sunshine permitted, but for reasons stated conversation was not entered upon. In other words, the operators signalled rapidly and readily, but they did not talk, as they might have done by preconcerted arrangement. Sufficient, however, was effected to demonstrate that, given an unclouded sun, the heliograph is a very efficient telegraphic instrument.

The uses to which the heliograph may be applied are very numerous, although it is not pretended that they are numberless. In military operations especially it would prove invaluable; if, for instance, the system had been in use by the French army during the siege of Metz, Marshal Bazaine could have communicated with the forces which were operating for his relief without hindrance, and in all probability France would not have experienced the disaster of Sedan. Looking at our Indian possessions, should another mutiny occur there, lines of telegraph wires would, of course, be cut and railways destroyed. At such a juncture the heliograph would prove invaluable, by maintaining communication between distant points. By its means, too, a detached force operating in hill districts could be connected with the main body of troops, or two forces like Wolseley's and Glover's in the late Ashantee war could be thus united and enabled to operate in concert. For reconnoitring, flanking, and reconnaissance parties, also, it would prove highly advantageous; it would not matter, so far as the operations were concerned, if a reconnaissance party were captured, because, unless surprised, they would have previously flashed their information back to the main army. It is not intended that the heliograph should supersede flag signalling, although in many cases it might be used with advantage in the place of flags, which are invisible at long ranges unless they can be displayed on the horizon. In fact, just at the point where flags fail the heliograph becomes useful.

The applications of the heliograph to civil purposes are not less numerous than those to military use. It would serve as a substitute for wires in countries where the electric telegraph would not pay, and where trunk lines existed they could be fed by the heliograph, which would effect communication with the outlying districts. It could be used for temporary purposes on special occasions inland, while there are countries on the coasts of which it might be substituted for expensive submarine cables. In the event, too, of short submarine cables failing, as they often do, it could be used for maintaining communication, provided the weather permitted. In short, the heliograph would appear to be an admirable adjunct to the electric telegraph in all countries, while in some it would supersede it with advantage. It is, as we have previously observed, already in use in India, and we are informed that our own Government, as well as several foreign Powers, are investigating its merits with a view to its adoption.—*The Times.*

CORRESPONDENCE.

NEW EXPERIMENTS ON ELECTRO-MAGNETISM.

A Monsieur le Redacteur du "The Electrical News."

Monsieur,—Je profite de la circonstance pour vous dire que M. E. Girouard dans l'article qu'il vous a envoyé a commis une erreur historique. *Il y a près de vingt ans que j'ai publié les expériences dont il parle,* et ces expériences ont même servi de base à toute ma théorie de la *Condensation Magnetique* que j'ai développée d'abord dans mon "*Etude du Magnetisme,*" publiée en 1858, et unedans foule d'autres travaux que j'ai publiés depuis sur l'électro-magnetisme; ce qui est curieux c'est que M. Girouard a sert du mot même que j'ai employé, c'est à dire du mot *condensation*, pour désigner l'accroissement de force qui résulte de l'action de la masse de fer (en dehors de la bobine) sur le pôle qui ne la dépasse pas et qui produit l'attraction. D'un autre côté je démontrais comme lui que grace à cet effet de condensation, on peut rendre les electro-aimants droits presqu' aussi énergiques que des electro-aimants à deux branches.

Quant à l'expérience en elle-même, elle n'est au fond qu'une répétition d'une ancienne expérience de Descartes qu'il décrit ainsi dans sa philosophie: "La force que posséde un aimant pour soutenir le fer peut diversement etre *augmentée ou diminuée* par un autre aimant ou par un *morceau de fer*, selon qu'il lui est diversement appliqué. . . . *Une lame de fer qui, etant appliquée contre l'un des pôles de l'aimant lui sert d'armure et augmente de beaucoup la force qu'il a pour soutenir d'autre fer, empeche celle qu'a le même aimant pour attirer ou pour faire tourner vers soi les aiguilles qui sont proches de ce pôle.* . ."

M. Nicklés quelque temps avant moi avait signalé le même effet, sans se douter qu'il ne faisait que répéter une expérience de Descartes. Il donnait d'ailleurs de ces effets une théorie tout à fait en dehors de la mienne.

Si je vous envoie cette note rectificative c'est que depuis quelque temps, plusieurs physiciens reviennent à ma théorie après l'avoir critiquée au moment où je l'ai émise; et ils en font la base de leurs découvertes sans mentionner le nom de celui qui s'en est occupé le premier. En conséquence je vous serai obligé de publier cette petite note.

Th. du Moncel.

[I shall be glad if you will allow me to point out that M. E. Girouard in his article in your last issue entitled "New Experiments in Electro-Magnetism" has fallen into an historical error. It is now nearly 20 years since I published the experiments of which he speaks; and these experiments have even served as the basis of my theory on *Magnetic Condensation* which I first developed in my "Etude du Magnetisme," published in 1858 and afterwards in a host of other works on electro-magnetism. Very curiously M. Girouard makes use of the same word that I have employed, namely, *condensation*, to designate the growth of force which results from the action of the mass of iron (extending beyond the bobbin)

upon the attracting pole flush with the bobbin. On the other hand, I showed like him that, thanks to this condensing effect, straight electro-magnets could be made possessing almost as much energy as horse-shoe magnets.

As to the experiment itself it is in the main simply a repetition of an old one of Descartes, which he thus describes in his "Philosophy":—"The force which a magnet possesses to enable it to sustain iron may be variously *increased or diminished* by another magnet, or by a piece of iron, according as it is differently applied. . . . *An iron plate applied to one of the magnet's poles serves as an armature, and much increases its sustaining force, whilst it impedes the force which the same magnet has to attract or to turn towards itself needles near this pole* . . ."

M. Nicklès some time before me remarked the same effect, without suspecting that he was merely repeating one of Descartes's experiments. He, moreover, based upon these effects a theory in all respects dissimilar to mine.

I may mention that for some time past several physicists have reverted to my theory after having found fault with it when first promulgated; and they have made it the basis of their discoveries without mentioning my name as the one who first occupied himself with the subject. I shall therefore be obliged to you if you will publish this little note.]

COMMERCIAL NOTES.

THE manager of the Direct United States Cable Company, Lim., has announced that the Company's Ireland Nova Scotia Cable has been interrupted near Newfoundland in shallow water. A repairing steamer will leave England in a few days to effect the necessary repairs.

With reference to the recent reduction in the American telegraph rates, the *Observer* of the 26th inst. says:—"The returns of the Anglo-American Company since the introduction of the shilling tariff have abundantly proved that the theory that the reduction in price will lead to a corresponding increase in messages, is a fallacy. Sir James Anderson, in his interesting volume on "Telegraph Statistics," had always maintained the contrary principle, and the facts have thus far fully justified his conclusions. It is not surprising that under these circumstances the shareholders of the two companies have impressed on their boards the desirability of coming to an agreement without loss of time. Every day implies the loss of £1000, for which the public will doubtless have to pay in the future, in the shape of higher rates than before the commencement of competition. We remember when the fare to Manchester and back was—owing to a temporary contest between the great railway companies—only five shillings. This boon was, however, not enjoyed beyond a few months, and the fare has ever since approached the maximum allowed by Parliament. All experience has, in fact, demonstrated that commercial undertakings cannot be carried on for any length of time without a sole regard to the interests of the shareholders, and that such pretensions as that of destroying a monopoly, and giving the public the benefit of cheap telegraphy, are simply clap-trap put forth for interested purposes. The cable service between this country and America is so admirably performed that it takes less time to receive an answer to a message from New York than from Paris. Yet three of the five cables actually working are fully sufficient for the traffic. It can therefore suit the interests of no body except the contractors, to lay down any more cables on the bed of the Atlantic; but, at the same time, the Direct United States Company must feel that as long as it owns one cable only, it is not in a sound position. It has therefore been suggested that the two companies should treat on the basis of an agreed proportion of traffic accruing to each company, whether their cables are in working order or not, and that a joint repairing and renewal fund should be set aside for keeping the cables of both concerns in an efficient condition. The various conventions of the Anglo Company secure to it a monopoly of the entire Continental traffic, and of all messages not specially directed to go by another route in England. It will therefore always obtain the bulk of the traffic, and these valuable privileges justify in some measure the addition to the original capital in the shape of bonus shares. Before the reductions of the tariff the normal income of the Anglo Company was about £700,000, and this amount, after deducting £250,000 annually for working expenses and reserves and repairs, is sufficient to pay dividends at the rate of about 5½ per cent. on the capital of the two companies. With six cables and a practical monopoly—which the public cannot wish to be interfered with as long as the tariffs are not unreasonably high—such dividends would render the shares of both undertakings a very desirable investment." In an article on the same subject the *Daily Telegraph* of the 29th inst. says:"The Direct Company had no right to expect immunity from the risks attending submarine enterprise, and we imagine the most sanguine shareholder must now regret that the occasion offered for a working agreement with the rival line within the last few days was not promptly seized. The chance has been lost, and the Anglo-American Board is left in possession of the field, with full licence to tax the public to the top of their bent. With traffic receipts of little more than £5000 a week, it was not likely so tempting an opportunity would be left unimproved, and accordingly we learn, without the least surprise, that the company will at once raise the tariff to what may be termed a paying point—that is, apparently, sufficient to yield the modest dividend of 4 per cent or thereabouts, which seems now to constitute the highest aim of Atlantic shareholding ambition.

The Board of the Anglo-American Telegraph Company have resolved to pay an interim dividend of 1 per cent, payable on November 1, for the quarter ending this day. The traffic receipts of the Company for the 23rd, were £980; for the 24th, £880; for the 25th, £820; for the 26th, £220; for the 27th, £700; for the 28th, £1090.

At a meeting of Hooper's Telegraph Works Company, held on Thursday last, the liabilities of the Company were shown to be £580,069, and the debit balance £73,428, and the cash in hand £54. A committee of inspection, consisting of five shareholders, was appointed, and the meeting was adjourned for a fortnight.

TELEGRAPH SHARE LIST.

Amount per Share.	NAME OF COMPANY.	Amount paid up.	Closing Quotations.
£		£	Sept. 29
Stock	Anglo-American	100	64½–[illegible]
10	Black Sea	All	[illegible]
10	Brazilian Submarine	All	[illegible]
10	Cuba	All	[illegible]
10	Ditto, 10 per cent Preference ..	All	13½–[illegible]
10	Direct Spanish	9	[illegible]
10	Ditto, 10 per cent Preference ..	All	[illegible]
20	Direct United States Cable	All	9–9½
10	Eastern	All	[illegible]
..	Ditto, 6 per cent Debenture	..	104–107
10	Ditto, Exten. Australia and China	All	[illegible]
10	German Union Telegraph and Trust	All	[illegible]
10	Globe Telegraph and Trust	All	[illegible]
10	Ditto, 6 per cent Preference	All	[illegible]
10	Great Northern	All	[illegible]
25	Indo-European	All	[illegible]
10	Mediterranean Extension	All	[illegible]
10	Ditto, 8 per cent Preference	All	[illegible]
10	Panama and South Pacific	2½	..–..
8	Reuter's	All	[illegible]
Stock	Submarine	100	[illegible]
1	Ditto, Scrip	All	[illegible]
10	West India and Panama	All	[illegible]
10	Ditto, 10 per cent Preference ..	All	[illegible]
20	Western and Brazilian	All	[illegible]
1000 dls.	Western Un. U.S. 7 per cent 1st M.B.	All	[illegible]
100	Ditto, 6 per cent	All	[illegible]
10	Hooper's Telegraph Works	All	[illegible]
50	India-Rubber and Gutta-Percha ..	All	[illegible]
Cert.	Submarine Cables Trust	100	[illegible]
12	Telegraph Construction	All	[illegible]
100	7 per cent Bonds	All	..–..

PATENTS.

APPLICATIONS FOR LETTERS PATENT.

3293. George James Symons, of Camden Square, Middlesex, for an invention of "Improvements in magnetic compasses."—Dated September 20, 1875.

NOTICES TO PROCEED.

990. Benjamin Theophilus Moore, civil engineer, of Elm Lodge, Spring Grove, Isleworth, Middlesex, has given notice in respect of the invention of "Determining the direction or magnetic bearing of deep sea or other currents."

PATENTS WHICH HAVE BECOME VOID,

By reason of the Non-payment of the additional Stamp Duty of £50, before the Expiration of the Third Year from the Date of such Patents.

2702. George Augustus Alexander Cunningham, and Thomas Philip Christopher Cunningham, electricians, of Liverpool, Lancaster, for an invention of "Improvements in electro-magnetic motors."—Dated September 12, 1872.

2739. William Morgan-Brown, of the firm of Brandon and Morgan-Brown, engineers and patent-agents, of 38, Southampton Buildings, London, and 13, Rue Gaillon, Paris, for an invention of "Improvements in telegraph apparatus."—A communication to him from abroad by James Rowe, of Paterson, New Jersey, U.S.A.—Dated September 14, 1872.

ABSTRACTS OF SPECIFICATIONS.

Improvements in the construction of electric light apparatus. Peter Jensen, of Chancery Lane, London. (A communication from Stanislas Vikentievitch Konn, of St. Petersburg, Russia.) March 16, 1875.—No. 970. A closed glass cylinder from which the air is pumped. Several carbon sticks of unequal length. A circular shield inside the lower part of the glass cylinder. Two copper conductors covered with glass are connected to the positive, the other to the negative pole.

Improvements in apparatus for transmitting musical vibrations or signals by means of electricity. John Henry Johnson, gentleman, of 47, Lincoln's Inn Fields, Middlesex. (A communication from Elisha Gray, of Chicago, county of Cook, Illinois, U.S.A.) March 16, 1875.—No. 974. This invention relates to apparatus for transmitting musical vibrations by means of electricity from a distance, which apparatus is known as the telephone, and the invention consists in the method of and apparatus for transmitting and receiving simultaneously or otherwise, on a single circuit, two or more musical tones of different pitch. It also consists in the combination of apparatus operating in the above-named manner with a series of Morse sounders or printing telegraph apparatus, each operated in its own local circuit, whereby it is rendered possible to transmit two or more messages simultaneously on a single main circuit.

PATENTS GRANTED IN FOREIGN STATES.

Belgium.

37,802. Sir C. Wheatstone, for an imported invention of "Improvements in the mode of and apparatus for applying electricity to give telegraphic signals."—Dated Sept. 3, 1875.—(English patent, August 5, 1875.)

United States.

165,570. *Circuits for Electric Signals.* Thomas S. Hall and Geo. H. Snow, West Meriden, Conn. Filed June 23, 1875.—Designed more particularly for railroad signals, the purpose being that whenever the circuit is closed the current shall be compelled to traverse the same distance, and the resistance shall thus always be the same. The combination, with a series of keys or circuit closers, C D, of a battery and two line wires, A B, one pole of the battery and one end of the line wire B being grounded, while the other pole of the battery connects with the line wire A, all constructed and operating substantially in the manner herein shown and described.

165,578. *Pocket Telegraph Relays.* E. A. Hill, Chicago, Ill., and H. J. Schneider, Philadelphia, Pa., assignors to E. A. Hill, Chicago, Ill. Filed June 18, 1875.—1. The combination of the magnets C, piece E, for securing the magnets, and making a trunnion support for the key, the stop plate N, and the key G, as specified. 2. The combination of the magnets C, stop plate N, sounder lever F, spring H, and inclined thumb-piece spindle I, as specified.

165,591. *Non-Interfering Fire-Alarm Telegraphs.* Jos. W. Kates, Richmond, Va. Filed April 28, 1875.—To prevent operating instrument from locking itself, a rack bar—carried by a pinion on a shaft of the clock mechanism—comes into the path of the locking stop. 1. The herein-described method of preventing interference of signals by connecting the instruments at the various signal stations by a second and independent electric circuit, which is opened or closed automatically, and operates the armature of an electro-magnet carrying a stop for the purpose of locking the clock mechanism to prevent the interference of signals, substantially as described. 2. The herein-described method of automatically operating the armature provided with a stop for the clock gearing by a non-conducting tape disposed and operated upon the same drums with the signal tapes, and having perforations at its extremity only, whereby the secondary circuit is closed when the instrument is not in operation, and is broken while the instrument is in operation, substantially as described. 3. The stop R, having the shoulder *f* in combination with the rack bar *g*, spring *i*, and pinion *h*, substantially as and for the purpose described.

165,602. *Circuits for Electric Alarms.* George C. Maynard, Washington, D.C. Filed April 24, 1875.—For use with show windows, cases, &c., the breaking of the glass breaking the circuit controlling an alarm. 1. The combination, with a supporting base or plate of glass, in any desired form, of a metallic medium, applied thereto in the shape of letters, numerals, pictures, or ornamental work or device, and forming an electric circuit, or part of a circuit, adapted to be interrupted upon the breaking or cutting of the glass, substantially as and for the purposes set forth. 2. An electric conducting sign formed of a conducting medium or pigment applied for an insulating base, substantially as set forth. 3. A sheet of glass of any desired form, provided with an electric conductor, arranged in the form of letters, numerals, pictures, or other ornamental work or design, substantially as set forth.

165,620. *Automatic Electric Telegraphs.* Wm. E. Sawyer, Washington, D.C. Filed February 2, 1875.—Polarised relay adjusted to rapid work, and restored to normal condition by adjustable permanent magnet O. Throws into line currents, battery, and secondary of opposite polarities. 1. In a polarised needle telegraph relay, the combination of a polarised needle and a projecting contact-piece operating with a needle, with a sliding bar magnet to act upon the polarised needle in the place of a spring, substantially as shown and described. 2. The combination of a line, transmitting battery and metallic contact-point, brush or roller therefor, with a magneto-electric or induction-coil apparatus, which throws into the line a current of one polarity and metallic contact-point, brush or roller therefor, substantially as shown and described. 3. The combination in an automatic or chemical telegraph, with a transmitting apparatus, of a galvanic battery, so arranged that galvanic currents of one polarity will be thrown into the line, and a magneto-electric or induction apparatus so arranged as to throw into the line induced currents of opposite polarity to the galvanic battery currents, as and for the purposes specified.

165,700. *Electric Boiler-Alarms and Registers.* William C. Baker, New York, N.Y. Filed June 23, 1875.—Circuit closed by high or low pressure through magnets, controlling a dial and step-by-step escapement, thus registering how often the rules as to maximum and minimum of pressure have been violated. An intermediate magnet in same circuit closes branch circuit to self-acting magnetic bell. 1. The combination, with a low water or pressure alarm and an electric circuit-closing apparatus, of an electro-magnet, step-by-step movement, and dial, to indicate the number of times the boiler has been neglected, substantially as set forth. 2. The combination, with a boiler-alarm and electric circuits substantially as specified, of 6-branch, circuit, electro-magnet alarm-bell, and automatic circuit-breaker, operated by the hammer, substantially as and for the purposes set forth.

165,728. *Transmitters for Electro-Harmonic Telegraphs.* Elisha Gray, Chicago, Ill. Filed June 28, 1875.—For securing greater uniformity of action of the magnets upon a steel reed vibrating to produce a certain note, and to transmit upon the line electrical impulses corresponding to the number of vibrations necessary to produce such note. 1. The combination, substantially as hereinbefore set forth, of the vibrating electrotome and magnets arranged on opposite sides thereof, of such relative capacity as to impart impulses of equal force at equal intervals upon each side of the vibrating electrotome alternately, whereby its isochronous vibration is secured. 2. The combination, substantially as hereinbefore set forth, of the vibrating reed, its counterpoise magnets, a local circuit, and the shunt-wire, whereby the current is automatically changed, to each set of magnets.

165,918. *Signal-Boxes for Fire-Alarm Telegraphs.* Moses G. Crane, Newton, Mass. Filed July 9, 1875.—Boxes in normally closed circuit. On the breaking of the circuit the armature levers are withdrawn by a spring. On taking against the fingers, closes a short circuit outside of magnet and circuit-breaking wheel, thus preventing a signal being given by any except the box first operated. In such box the mechanism is released by raising a lever having a lug in recess of the wheel, a tooth taking against a lever and locking it, to prevent the formation of the short circuit in each box. 1. In a fire-alarm signal-box the lever G, with its lug V and hook *t*, the flange *p* and its notches V′, the lever *b*, insulated plate *e*, and magnet D, all combined and operating as and for the purpose specified. 2. The combination of the lever H, the lever G, and the wheel F, whereby the said wheel is liberated and allowed to revolve under the stress of the motor C, a; and for the purpose specified.

165,923. *Telegraphic Fire-Alarm Repeaters.* John N. Gamewell, Hackensack, N.J., M. G. Crane, Newton, and E. Rogers, Boston, Mass. Filed July 9, 1875.—1. The combination, with a break-circuit wheel of a telegraph repeater, upon which the lines of two or more circuits converge, of a governor, whereby, when a signal is being given over any one of the circuits, and repeated over the other circuits, the armatures of the magnets in such other circuits are locked in position, thereby preventing interference between the several circuits, as and for the purpose specified. 2. The auxiliary escapement movement, in combination with the governor J and the break-circuit wheel, whereby the reverse movement of the governor is not permitted to take place during several successive revolutions of the said wheel, as and for the purpose specified. 3. The auxiliary escapement movement, the circuit-wheel and its shaft, and the lever 25, combined and operating as described, whereby, after the winding up of the escapement by the revolution of the circuit-wheel shaft, the reverse motion of the said lever is prolonged and graduated, as specified. 4. The combination, in an electro-telegraphic repeater, of two electro-magnets in the same circuit, one of which has a larger core than the other, whereby there results an appreciable difference in the periods required for them to be charged and discharged, respectively, as and for the purpose specified. 5. The device described, whereby the breaking of any one of several circuits connected with the repeater for the purpose of signalling occasions the break-circuit wheel to be cut out from that circuit by closing the same over auxiliary fingers *x x′*, all combined and operating as and for the purpose specified. 6. The auxiliary magnets F F′, with their armatures and hooked lever M, in combination with the armature lever H and swinging lever D, as and for the purpose specified. 7. The combination of the swinging lever D with its two stop pins, and the arm *l*, with its two fingers *s s′* upon the break-circuit wheel shaft, as and for the purpose specified. 8. The combination of the cam 28, levers 22 and 25, and sliding bar 18, as and for the purpose specified. 9. The combination of the governor J, bar 18, lever 25, and latch 37, as and for the purpose specified. 10. The lever I, with its short arm 10, the armature lever H, and lever D, and the governor J, combined and operating as and for the purpose specified. 11. The auxiliary escapement *y y′*, with its train 31 32, in an electro-telegraph repeater, employed to graduate the movement of the mechanism by which said train is actuated relatively to the movement of another telegraphic repeating mechanism.

166,012. *Galvanic Batteries.* J. Kidder, New York, N.Y. Filed April 24, 1875.—1. A cell-casing for galvanic batteries having interior cell forming partition walls, made at less height than outer walls, for enabling rapid filling and emptying of cells, substantially as and for the purpose specified. 2. A cell-casing for galvanic batteries provided with outer walls of greater height than the interior partition walls, and having a supply reservoir with flanged gutter and spout for the more rapid emptying and filling of the cells with the fluid, substantially as and for the purpose set forth. 3. The subdivided guide-frame seated in main cell-case, and connected with vertically moving element carrying top plate, as shown and described, thus admitting of the lateral removal of cells and insuring the insertion of each element in its proper cell when depressed, substantially as set forth. 4. The diagonal pivoted straps E E, to command the parallel immersion of the elements into the solution of the cells, substantially as and for the purpose specified.

166,095. *Electric Telegraphs for Transmitting Musical Tones.* Elisha Gray, Chicago, Ill. Filed January 19, 1875.—Depends primarily on fact that the core of a magnet expands and contracts, causing vibrations as it is made and unmade. Currents corresponding in number to the vibrations necessary to produce any particular note are transmitted, causing corresponding vibrations in core of magnet, which are transferred to a sounding-box placed in the magnet. The combination of a telegraphic circuit, a series of circuit-breakers capable of producing musical tones of different pitch, a series of keys for simultaneously or successively throwing said circuit-breakers into or out of operation, and an electro-magnet receiver, which is thrown into operation by the transmitters, whereby tones of different pitch may be reproduced at the receiving end of the line by the employment of a single circuit.

TO CORRESPONDENTS.

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London: Printed and Published by the Proprietor, WILLIAM CROOKES, at the Office Boy Court, Ludgate Hill, E.C. September 30, 1875.

THE

ELECTRICAL NEWS

AND

Edited by Wm. Crookes, F.R.S., &c.] TELEGRAPHIC REPORTER. [Registered for Transmission Abroad.

Vol. 1.—No. 15.] Thursday, October 7, 1875. [PRICE, 4d. POST FREE, 4½d.

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THE ELECTRICAL NEWS.

Vol. I. No. 15.

FURTHER NOTE ON THE ELECTRIC CONDUCTIVITY OF MINERAL SUBSTANCES.*

By the Count TH. DU MONCEL.
Membre de l'Institute de France.

My former notes† treated of the electric conductivity of stones. I there avoided the question of the conductivity of metallic minerals, because they display peculiar phenomena, to determine which necessitated a profound study of simple stones. In my note of October 5, 1874, I referred to this subject reservedly, having resolved to discuss the question on another occasion. At the present time I feel obliged, on account of the publication of MM. Braun's and Dufet's works, to no longer defer the recital of my own researches, although it would have suited me better to have first experimented on a greater number of metallic ores. Nevertheless, the obtained results are so well defined that they will show how the effects produced on the conductivity of these kinds of substances are not so simple as generally supposed.

Metallic ores are far from behaving uniformly in the transmission of electric currents. Some react like ordinary stones; others comport themselves in a manner analogous to that of metals, and others, again, have a conductivity which participates (to a marked degree) in the two sorts of conductivities. These last are those which furnish the most interesting effects, and amongst them I will quote *oligist iron*, in the condition of *specular iron*; *wolfram* (tungstate of iron), of which I have already spoken; and *magnetic iron*.

In general the ores which yield these last effects have a poor conductivity for metallic ores, yet a considerable one in comparison with that of ordinary stones. The samples of oligist iron (Fe_2O_3) experimented upon had a resistance of 2048 kilometres at a temperature of 20°; Wolfram, at the same temperature, gave a resistance of 103,466, and magnetic iron, 256 kilometres. In their normal state these minerals yielded under the influence of a traversing current those electrostatic and electrotonic effects to which I referred in the case of hard stones of a siliceous origin, particularly Heronville flint. Thus oligist iron, with a 4 kilometre shunt, gave at the commencement of the experiment a deflection of (90° to 80°), which fell to 81° at the end of five minutes, at which it was maintained for ten minutes; and *I have been able to obtain a polarisation current of* (90° to 82°) *at the commencement, falling only to* 40° *at the end of twenty minutes.*

So far, however, we find nothing not included in the effects already described. But when we heat the mineral ore fresh effects become evident of a character different from those shown by simple stones. Thus, when I heated Heronville flint with an alcohol lamp, I certainly determined, at the first moment, a slight action on the transmitted current, which was effected in a variable direction; but at the end of some seconds a considerable weakening of the current took place, and continued even after the lamp had been removed. It is quite otherwise with oligist iron. *The deflection always increases whatever the end of the ironstone is heated*; and, if the transmitted current be broken, an energetic current can be obtained by joining up the two ends of the ore to the galvanometer. This is not a polarisation current; for its direction varies according to which end of the stone was last heated: its direction, however, in the exterior circuit, is always from the heated to the cold extremity.

In this reaction produced by heating, *the polarisation current due to electrostatic action is then cancelled, and gives place to a genuine thermo-electric current whose direction is naturally according to the hotter of the two electrodes.* These currents are comparatively energetic; for by heating one of the electrodes some seconds, without the interposition of the voltaic current, 90° can be rapidly reached. On the other hand, we can likewise very quickly annihilate this last current (without waiting till the substance be grown perfectly cold) by warming the other electrode. This is one method by which I ascertained the real influence of heat in these ironstones. In fact, thermo-electric currents being unable to exist but for a difference of temperature between the two ends of the ironstone, I was able by this method to eliminate their interference, and to examine the play of calorific action in the conductivity of these descriptions of minerals, apart from every perturbing cause. Thus have I been able to discover that the deflection (13° to 11°) produced by the voltaic current (with 100 metre shunt) when the stone was cold, became (35° to 27°) when it had been alternately warmed until the attainment of a uniform temperature. Under these conditions, when I warmed the stone at the positive electrode, the deflection rose in a few seconds from 27° to 34°, and when I took away the lamp, it returned to 27° in a few moments. By afterwards heating the other electrode, the increase in the current's strength was effected in the same manner, though much quicker, no doubt because the thermo-electric current is then developed in the same direction as the voltaic current; but the deflection returned to its starting point more slowly. After breakage of the voltaic current, the remanent thermo-electric current was 19°, and in the direction which the last heating would determine. Lastly, when the ironstone had grown quite cold, the passage of the voltaic current again caused a current whose deflection was (13° to 11°) as primarily observed. This became 12° at the end of ten minutes, and the current arising from the stone (no longer this time a thermo-electric current) furnished a deflection of (90° to 55°) which became 11° at the end of half an hour.

Analogous results are produced with wolfram, which, at the beginning, having furnished (with a 128 kilometre shunt) a deflection of (90° to 67°) reduced to 63° after ten minutes, and 64° after one hour and ten minutes, set up a polarisation current of (10° to 8°), which fell to 5° in ten minutes. Now this stone being heated at the positive electrode, the strength of the current rose to 79° in a few seconds, and to 90° by heating the other electrode. In order to ascertain the influence of the thermo-electric effects, I interrupted the current, and, after joining up the stone to the galvanometer, I was able to verify (by alternately heating the two electrodes) some inverse thermo-electric currents quite as energetic as those determined from the preceding ironstone.

Magnetic iron ($FeO+Fe_2O_3$) has strikingly similar results as the two ironstones just discussed, only the electrotonic are of greater importance than the thermo-electric effects.

When metallic minerals have a great conductivity, such as *galena*, *ferrous sulphide*, &c., whose resistance in the experimented samples did not exceed 700 and 300 metres of telegraphic wire, the transmitted current *varies little in strength, and furnishes no polarisation current, no matter how long the circuit may be closed.* Metallic conductivity then becomes preponderant, and the effects characteristic of metallic substances become more or less manifested. *Heat then diminishes its conductivity as it does that of metals*, and the thermo-electric currents resulting from heating the electrodes do not suffice to change the conditions of transmission which have been made in the voltaic current. It is true that the portion of the current that passes through the galvanometer is then so weak, because of the shunt, that it required an electric potential far superior to that of these thermo-electric currents in order to affect a voltaic current so powerful as the current I made use of.

* Communicated by the Author.
† See Electrical News, pages 153 and 165.

The following table shows the results obtained by joining up the two ends of the galvanometer wire to the ore samples by another wire of extremely feeble resistance:—

	At the Beginning.	After Heating. Five Minutes After.	The Positive Pole.	The Negative Pole.
Galena	(80°—56°)	59°	56°	54°
Ferrous sulphide	(76—56)	58	55	54

In these two cases no polarisation current was determined by the voltaic current; but when heated at either one or the other of the electrodes, energetic inverse thermo-electric currents were obtained, at the end of a few seconds, of 90° strength, *whose direction was always from the heated to the cold portion.* Though these currents did not affect the voltaic current, they were manifested immediately that the voltaic current was broken and the shunt removed, and they naturally varied in direction according to the end of the ore last warmed. On warming it between the two electrodes, unstable currents were at first obtained, which varied more or less frequently in direction; but they ended by taking a fixed direction, and augmented in strength so long as the ore continued to be heated. When the heating was stopped the currents of course became weakened, though they persisted until the minerals had grown quite cold.

When metallic minerals have only a weak conductivity, like cinnabar (a mercury sulphide HgS), they produce neither thermo-electric nor polarisation currents, and it so happens that warmth slightly augments their conductivity. Thus a large sample of cinnabar, very heavy and of a very metallic appearance, only gave a conductivity of 3°, and this took more than a minute to become manifest. Under these conditions it is very evident that the charge current (referred to in my previous paper) does not exist, and the current transmitted directly through the metallic molecules passed in an extremely long variable period. Heat raised its strength from 3° to 10°, then it decreased as a consequence of the cooling process; and when the other end was heated a slight augmentation was again the result, but much feebler than the first.

It is a very important statement that *the conductivity of metallic minerals does not appear to be affected by atmospheric moisture, even when they yield the effects common to ordinary stones.* Thus wolfram and oligist iron gained no extra conductivity after being deposited in a damp cellar for twenty-four hours,—showing that electrolytic conductivity does not exist in this class of substances.

In order to study the possible consequences of the presence or absence of this description of conductivity in stones, I examined my Heronville flint (which possesses it in a marked manner) to see whether it would produce of itself thermo-electric currents. After having damped it sufficiently to conduct my current with its ordinary strength of 70° to 80° (shunt being 4 kiloms.), I joined up the two electrodes to the galvanometer, and, after the reduction of the polarisation current to 8°, I warmed one of the electrodes, so as to obtain a thermo-electric current in the direction of this deflection. In a few moments the deflection went up to 15°, which, however, dropped directly the lamp was removed. Then, warming the other electrode, the needle soon went back to 0°, which it did not pass; and when I again re-heated the ore, at the opposite end, no effect was obtained.

This experiment leads to the following conclusion:—*Hard, non-metallic stones are well able to beget thermo-electric currents so long as they remain conductors, but, as heat considerably and rapidly increases their resistance, these currents (after a certain degree of heating) can no longer be developed.* It is probable that the return of the needle towards zero, at the time of the second heating, was rather owing to the absence of conductivity than to the action of an inverse thermo-electric current.

From all these experiments we may deduce that—

1. When metallic minerals have a certain degree of conductivity they generally beget thermo-electric effects under the influence of heat, and this influence increases or diminishes the conducting property of minerals in proportion as the resistance becomes greater or less.

2. Certain metallic minerals may yield the electrostatic and electrotonic effects so remarkable in hard stones, and flints in particular. But to these effects they unite those which proceed from thermo-electric actions, and, when they are simultaneously present, those determined by thermo-electricity predominate. In every case these minerals are not affected by atmospheric moisture.

3. Minerals which are in the position of those just debated are relatively resisting—less, however, than ordinary stones; consequently heat increases their conductivity.

4. Minerals having a great metallic resistance, and which have not a well-developed electrostatic capacity, possess a very feeble metallic conductivity. They do not determine sensible thermo-electric currents, and warmth slightly increases their conductivity.

5. Minerals having only a well-developed metallic conductivity yield strong thermo-electric effects, but heat diminishes their conductivity, and those effects which are the consequence of electrotonic conductivity are not met with.

PRELIMINARY NOTICE ON THE CHANGE PRODUCED BY MAGNETISATION IN THE ELECTRICAL RESISTANCE OF IRON AND STEEL.*

By Professor W. G. ADAMS, F.R.S.

For some time past Mr. Herbert Tomlinson, Demonstrator in the Physical Laboratory of King's College, has been engaged in carrying out a series of experiments on this subject, and also on the effect of change of tension on the electrical resistance of steel and iron wires.

In measuring the resistances of the short lengths of the wires or rods which were employed, a unit was chosen which was a small fraction of the British Association unit.

Experiments were made with rods of soft iron about ⅛th of an inch thick, with soft steel, and also with steel of different degrees of hardness.

With a rod of soft iron about 3 ft. long there was an increase of resistance of about 1 per cent. on magnetising with two Grove's cells. The whole resistance of this rod was 32 units.

The experiments were repeated with the rod placed in ice and also in water at the ordinary temperature (about 15° C.), and with nearly the same change in the resistance of the rod. The change in the temperature of the water was found to be about 1° C. during the experiment.

Another rod of soft iron was employed whose resistance was 50 units. The magnetising current was measured by means of a tangent galvanometer, and the resistance was measured by means of Wheatstone's bridge. There was found to be an increase in the resistance of the rod when it was converted into a magnet by sending the magnetising current through a wire which was coiled round it in the form of a spiral.

It was found that the electrical resistance was increased when any addition was made to the strength of the magnetising current. When the increase in the electrical resistance was divided by the square of the strength of the magnetising current, a series of numbers was obtained which did not differ much from one another; the values of these numbers mostly lie between 3 and 4.

When the magnetising current is considerably increased, the ratio of the increase in the resistance to the square of the magnetising current diminishes rather rapidly.

* A Paper read before the Royal Society.

A similar series of experiments was made with a thick knitting-needle made of *soft steel*. The resistance of the needle was 29 units. In this case also the resistance was found to *increase* when the strength of the magnetising current was increased. On dividing the increase of resistance by the square of the magnetising current, the numbers obtained from a considerable number of experiments lie between 4·7 and 5·6, showing that the ratio of the increase of resistance to the square of the magnetising current is very nearly constant.

When the magnetising current is considerably increased, this ratio is found to diminish, just as in the case of soft iron.

Different kinds of *hard* steel were tried.

(1). An ordinary knitting-needle, of which the resistance was 66·5 units.

On magnetising with currents of different strengths, there was found to be a diminution in the resistance; and it was also found that the diminution of resistance increased when the strength of the current was increased. With currents varying from tan 15° to tan 54° 30′ the diminution amounted to 4·33, *i.e.* about 6·5 per cent of the whole resistance. The temperature *increased* about 2° C. during the experiment.

Dividing the loss of resistance by the square of the magnetising current, the results of four sets of experiments gave the following values:—

$$\frac{0{\cdot}165}{(\tan 15^\circ)^2}=2{\cdot}29,$$

$$\frac{0{\cdot}7525}{(\tan 30^\circ)^2}=2{\cdot}26,$$

$$\frac{2{\cdot}3225}{(\tan 45^\circ\ 30')^2}=2{\cdot}24,$$

$$\frac{4{\cdot}330}{(\tan 54^\circ\ 30')^2}=2{\cdot}21.$$

Four Grove's cells were employed for the strongest current.

Two other experiments which had been tried previously gave results 2·30 and 2·26 for the ratio of the diminution of resistance to the square of the magnetising current, thus showing that the diminution in the resistance is almost exactly proportional to the square of the current.

The diminution in the resistance does not take place all at once, but gradually, and also ceases gradually when the current is stopped.

(2). A steel needle was also magnetised longitudinally by placing it on a copper strip at right angles to the lines of force of a current across the strip.

There was found to be diminution of resistance on increasing the current. The values obtained from two series of experiments were:—

$$\frac{0{\cdot}064}{(\tan 8^\circ\ 30')^2}=2{\cdot}88,$$

$$\frac{0{\cdot}192}{(\tan 15^\circ)^2}=2{\cdot}63.$$

With stronger currents this ratio was found to diminish.

On magnetising the wires transversely by sending a current in the direction of their length, a diminution of resistance was also observed, which diminution also increased when the strength of the current was increased.

When a current was sent along the wire itself, on increasing the current there was found to be also a diminution of resistance in the case of hard steel, and an increase of resistance in the case of soft iron and soft steel.

Thus the effects produced are the same as those due to transverse magnetisation by a neighbouring current.

Conclusions to be drawn from the experiments:—

(1). The effect of passing any current through a bar of hard steel is to diminish its resistance, and through a bar of soft iron or soft steel is to increase its resistance.

(2). When a bar of hard steel is magnetised by sending a current through a coil which encloses it, there is a diminution of resistance which is directly proportional to the square of the magnetising current up to a certain limit.

(3). When soft steel or soft iron is magnetised longitudinally or transversely, there is an increase of resistance which is nearly proportional to the square of the magnetising current.

ON A NEW FORM OF DYNAMO-MAGNETO-ELECTRIC MACHINE.*

By S. C. TISLEY.

IN the first machines constructed by Siemens and Wheatstone in 1867 (see Royal Society's *Transactions*) the power of augmenting the magnetism by successive currents, developed from the original residual magnetism contained in the iron, was fully demonstrated, and it was shown that the power of the machine could thereby be developed to a great extent; but the only means for obtaining external work was by the insertion in the circuit of a magnet or coil so that the secondary discharge could be utilised. Sir Charles Wheatstone also showed that a great part of the current could be shunted through a platinum wire, care being taken that the resistance of the platinum wire was sufficient to compel a large part of the current to pass round the electro-magnet.

In the same year the writer designed a machine which was made by Mr. Ladd, and described by him in a paper read before the Society (see *Transactions*), the principle of which was that two separate armatures being introduced, one was employed for magnetising the machine, the other being used for external work. This machine gave a good electric light, &c., and was shown in the Exhibition of Paris, 1867, when a silver medal was awarded for it.

To simplify this machine, the author of this paper afterwards placed the two armatures in the same groove between the poles of the electro-magnet, bolting the two together at right angles to each other, so that they came under the influence of the magnetism alternately; by this method one pair of bearings was sufficient instead of two, and the machine altogether was much simplified.

The machine now about to be described is a still further modification, in which the greatest amount of simplicity and effective power are combined.

The apparatus consists essentially of an electro-magnet with shoes, forming a groove in which a Siemens armature is made to revolve: this is much the same as the original machines made by Siemens and Wheatstone; but the difference occurs in the break or commutator; here there are two springs or rubbers employed in taking the current off from the commutator. The commutator consists of three rings: one of these rings is complete for three quarters of the circle, the other quarter being cut away; another ring is cut away three quarters, leaving the one quarter; and in between these two rings is a third ring, insulated and connected with the insulated end of the wire wound round the armature; on this centre ring are projecting pieces, one a quarter of a circle and the other three quarters, so arranged as to complete the two outer circles. The rubber spring which comes into contact with the quarter of the middle circle is connected with the electro-magnet of the machine, and the armature is so arranged that at the time of contact the best magnetising current is developed. The other spring rubber is in connection with the wire on the armature during the other three quarters of its revolution; and this is

* A Paper read before the Royal Society.

connected with any external piece of apparatus required to be worked.

By this arrangement, the alternate currents being utilised, they are all in the same direction; and by the length of contact the whole of the current is obtained in the best condition for heating wires, decomposing water, giving an electric light, and other usual experiments.

At present a model machine has been constructed on this principle, the armature of which measures 5 in. long by 2 in. diameter, on which is wound about 50 ft. of cotton-covered copper wire, No. 16 B. W. G. The magnet has about 300 ft. of covered copper wire, No. 14 B. W. G.: the whole instrument, without the driving gear, weighs 26 lbs.: with this apparatus 8 in. of platinum wire, 0·005, can be made red hot, water is rapidly decomposed, &c.

The armature is constructed specially to prevent the accumulation of heat to which every class of dynamo-magneto-electric machine is liable. It is made in two halves, a groove of zigzag form being cast in each half, so that when the two are screwed together a continuous channel is maintained through the bearings for a current of cold water to pass during the whole time the machine is at work.

The advantages suggested by these arrangements are their extreme simplicity, the few number of parts, only one armature and one wire being used.

This principle of the alternate current being utilised is also applicable to machines constructed on the multiple armature principle; and the economy thereby resulting would prove of great advantage, as the power of the machine could be varied by throwing into the electro-magnets either every other current, or every fourth, sixth, or eighth current, according to the strength required in the machine, the whole of the other currents being utilised for electric light or otherwise.

ON THE PRESSURE OF ELECTRICITY, AND ON ELECTRIC ENERGY.*

By M. BLAVIER.

The free electricity at the surface of a conducting body exercises against the air, or the insulating substance surrounding the body, a pressure which may be estimated in units of force.

In some treatises on electricity $4\pi\rho^2$ is given as the expression for this pressure referred to the unit surface, ρ being the density of the electricity, or the thickness of the electric layer. This formula is incorrect: the true value of the pressure, in function of the absolute unit of force, is $2\pi\rho^2$.

To find the pressure, we consider a small element of surface ω, on which there is an electric layer $\omega\rho$: the force which would act on the unit of quantity of electricity concentrated at any point of the space is due to the action of the element ω, and to the resultant of the forces, produced by all the other electric masses of the field. When the point considered is situated at an infinitely small distance from the surface, the action of the element ω, which we may consider as a small plane covered by a layer of uniform thickness ρ, is $+2\pi\rho$ if the point is at the exterior of the conducting body, and $-2\pi\rho$ if it is in the interior.

In the second case, the force due to the element ω makes equilibrium with the resultant of the actions developed by the other masses, a resultant which is, consequently, equal to $+2\pi\rho$; in the first case it is added to this resultant, and the total force is $4\pi\rho$.

The force, then, which acts on the unit of electric mass passes from 0 to $4\pi\rho$ for a point which traverses the electric layer, but the increase only takes place progressively, for the thickness of the layer, though smaller than any measurable quantity—is not *infinitely small* in the mathematical sense of the word.

We obtain the expression $4\pi\rho^2$ for the pressure, in applying the force $4\pi\rho$ to the electric mass $\omega\rho$ of the element, which gives $4\pi\rho^2\omega$ or $4\pi\rho^2$ for unit of surface; but this is wrong, for the force $4\pi\rho$ is not constant over the whole extent of the layer. To have the force to which the mass $\rho\omega$ is subjected, it is necessary to take the resultant of the actions of the whole system, less the element ω, by the unit of mass concentrated at the point where the latter is, and to multiply this resultant $2\pi\rho$ by the electric mass $\rho\omega$, which gives $2\pi\rho^2\omega$ or $2\pi\rho^2$ for the pressure corresponding to the unit of surface.

Evaluation of the Pressure.

When the density ρ is uniform, which is the case with electrified spheres, or condensers, with plane parallel or cylindrical surfaces, when account is not taken of the increase of density at the edges, its value is deduced easily from the potential of the charge.

Thus, for a sphere of radius r, electrified by an electric source whose potential is V, the electrostatic capacity of the sphere being r, the charge is Vr; and the density ρ, equal to the proportion of the charge to the total surface, is—

$$\rho = \frac{V}{4\pi r}.$$

The pressure P, per unit of surface $P = 2\pi\rho^2$, becomes—

$$P = \frac{V^2}{8\pi r^2}.$$

According to the experiments of Sir W. Thomson the potential of a Daniell element has for value, in absolute units, the number 0·00374, taking fundamental units of time, of length, and of mass; the second, the centimetre, and the mass and cubic centimetre of water. The value of this potential is 0·000374, if we adopt the metre as unit of length.

The potential which an ordinary machine may develop depends on its form, the force put in action, the greater or less insulation of its conductors, and, lastly, the hygrometric state of the air. The good electric machines of cabinets of physics, according to experiments made by Sir W. Thomson, develop a potential nearly equal to that of a pile composed of 80,000 Daniell elements, and which may therefore be valued at 29·92 or 30 units. Two small spheres of 1 c.m. diameter, electrified to this potential, and 1 decimetre apart, would repel each other with a force of about 0·22 grm.

The electric pressure at the surface of a sphere in communication with a machine which would develop this potential would then be $\frac{900}{8\pi r^2}$ per square metre, or $\frac{0{\cdot}09}{8\pi r^2}$ per square centimetre.

For a sphere 2 c.m. in diameter this pressure would be equal to 36 absolute units of force, or to 3·6 grms. It would produce, at the surface, a diminution of the atmospheric pressure of 3·6 grms. per square centimetre, or of 2·6 m.m. of barometric height. If the sphere were an electrified soap-bubble, its diameter would increase till a new equilibrium was established between the interior pressure and the pressure of the air, diminished by electric pressure and the molecular forces.

The electric pressure would make equilibrium with the atmospheric pressure for a small sphere, the radius of which was such that $\frac{0{\cdot}09}{8\pi r^2} = 10{,}000$, or whose radius was equal to $\frac{6}{10}$ of a millimetre.

Let us, further, conceive two metallic plates separated by a plate of glass of thickness d, one of them communicating with the earth, and the other with an electric source having potential V. The density is the same as

* *Journal de Physique.*

the two substances in presence of each other, and has for value—

$$\rho = \frac{V \times c}{4 \pi d},$$

c being the specific inductive power of the glass, which is equal to 1·80. The pressure P exercised by the fluid against the surface of the glass is—

$$P = \frac{V^2 c^2}{8 \pi d^2}.$$

If $V=30$, and if the glass is 2 m.m. in thickness, we find for the value of P, per square centimetre, $P = 293$ grms. This is the pressure to which the plate is subjected on either side, over and above that of 1 kilogrm. due to the atmospheric pressure.

Evaluation of the Energy of an Electric Battery.

An electrified condenser contains a certain quantity of energy, which, in the latent or potential state, while the equilibrium subsists, is transformed into work, *vis viva*, or heat. When the electricity passes from one armature to the other we may express this energy in ordinary units of work (kilogrammetres), or of heat (calories).

If Q represents the charge of the interior armature of the condenser, S its electrostatic capacity, and V the potential of the charge, and if these three quantities are expressed in absolute electrostatic units, the energy E of the battery has for value, in absolute units of work, $E = \frac{1}{2} V Q$, which may be put in the form $E = \frac{1}{2} V^2 S$, or, again, $E = \frac{1}{2} \frac{Q^2}{S}$.

The capacity, S, of a Leyden jar, which may be considered as formed of two concentric cylinders situated at a very short distance from each other, is, neglecting the increase of density at the edges, $\frac{A \times c}{4 \pi d}$, A being the total surface of each armature, d their distance, and c the specific inductive power of the matter which separates them.

Suppose an electric battery formed of n jars, having each a height a and a diameter b; we have—

$$A = n \pi a b \text{ and } S = \frac{n a b \times c}{4 d}.$$

The energy of the battery in kilogrammetres, is, then,—

$$E = \frac{V^2 n a b \times c}{8 d} \times \frac{1}{1000 g},$$

and in calories,—

$$E_1 = \frac{V^2 n a b \times c}{8 d} \times \frac{1}{4168800}.$$

Supposing 2 m.m. to be the thickness of the glass which separates the armatures, and 1·80 the specific inductive power, c,—

$$E = 0·0115 \text{ kgm.} \times V^2 n a b,$$

$$E_1 = 1 \text{ cal.} \times \frac{V^2 n a b}{37053}.$$

If the battery is charged with a strong electric machine developing a potential equal to 30 electrostatic units, we have, substituting $V=30$ in the preceding formulæ,—

$$E = 10·35 \text{ kgm.} \times n a b,$$

$$E_1 = 0·0243 \text{ cal.} \times n a b.$$

For a single Leyden jar, 40 c.m. in height and 12 c.m. diameter—

$$E = 0·4968 \text{ kgm.}$$

$$E_1 = 0·001207 \text{ cal.}$$

If the battery comprises ten similar jars—

$$E = 4·968 \text{ kgm.},$$

$$E_1 = 0·01207 \text{ cal.}$$

To completely charge the battery, then, it is necessary to expend—beside the frictions and losses of force due to the imperfection of the machines—a quantity of work equal to 4·96 or 5 kilogrammetres—that is to say, corresponding to the elevation of 1 kilogrm. 5 metres in height.

When the battery is discharged there is developed a quantity of energy equal to 5 kilogrammetres, the effect of which is the same as the shock of a hard mass weighing 1 kilogrm. which should fall from 5 metres' height. We cannot be surprised, then, at its severe action on the nervous system.

If the discharge takes place through a very resistant wire, the energy is transformed almost completely into heat, which is absorbed by the wire and heats it. This quantity of heat, equal to 0·1207 cal., would raise 1 grm. of water 12·07° C. and 1 grm. of iron 106°.

If the conductor is a small iron wire, $\frac{3}{10}$ m.m. in diameter and 1 metre in length, and its weight 0·25 grm., it will be raised to a temperature of 414°. As iron fuses at 1500°, we shall have the length l of the wire which will be fused by the discharge by putting $\frac{414}{l} = 1500$, whence $l = 0·27$ m

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THE PRESERVATION OF TIMBER BY COPPER SALTS.

By M. ROTTIER.

(Concluded from page 158).

Since prepared wood is liable to alteration so soon as it contains but very minute quantities of copper, it would seem probable that increasing the quantity of metal will prolong its life.

The ordinary method of wood preparation does not afford an answer to this problem. When the wood is immersed in sulphate of copper solutions the proportion of metal combining with its ligneous fibre is always nearly constant and very small. Larger quantities of copper can only be introduced into the pores of the wood by using special processes. The following means have given good results:—

1. *The Use of Acetate of Copper.*—The various cupric salts do not enjoy, in the same degree, the property of fixing themselves upon the wood; acetate merits special mention amongst those I have tried. The following figures represent the quantities of copper which I have found in a certain number of chips prepared with different cupric acetate solutions: they are calculated to the condition of $CuSO_4 + 5HO_2O$:—

	Grm.
1 grm. prepared wood contained	0·0104
1 ,, ,, ,,	0·0125
1 ,, ,, ,,	0·0100
1 ,, ,, ,,	0·0170
1 ,, ,, ,,	0·0166

whilst the samples prepared with sulphate of copper generally contained only 0·006 to 0·0007 grm. of sulphate per grm. of wood.

2. *Heating the Prepared Wood.*—When, after having withdrawn the chips from the cupric solutions (sulphate, acetate, &c.) into which they had been plunged, they are exposed to a high temperature, the wood absorbs and retains—under the form of insoluble combinations—a rather greater quantity of copper than from the ordinary processes. The following table gives the results of some mixtures of copper upon chips heated after preparation:—

	Grm.
Chip prepared with sulphate of copper, and heated to 65° C.	0·0075
Ditto, ditto, heated to 100° C.	0·0090
Ditto, ditto, heated to 125° C.	0·0114
Chip prepared with acetate of copper, and heated to 100° C.	0·0231
Ditto, ditto, heated to 130° C.	0·0240
Chip prepared by the ordinary method.. ..	0·0073

3. *Use of Organic Substances.*—Some organic bodies act with respect to copper salts as pigments do in reference to colouring matters. Introduced into the ligneous fibre they fix themselves there, and enable it to occasionally absorb very considerable quantities of copper. The results of some experiments are as follows:—

(*a.*) *Indigo.*—A chip of wood tinted to a very pale blue by indigo was prepared with sulphate of copper. It contained, per gramme, 0·0093 grm. of copper—that is to say, a little more than wood prepared in the ordinary manner. A second trial was made with a piece of very intensely blue cotton cloth. After being treated with a cupric sulphate, washed, &c., it was found to contain 0·00409 grm. per gramme of cloth, whilst white cotton cloth scarcely absorbed 0·001 grm. A last experiment on this substance was made with a piece of printed cloth, of a deep indigo-blue colour, interspersed with white spots. After preparation these spots were carefully cut out and put on one side by themselves. This was done so as to separately dose the copper contained in the white and blue portions of the cloth. Tested, it was ascertained that—

	Sulphate of Copper.
1 grm. of cloth (white portion) contained	0·00026 grm.
1 „ „ (blue portion) „	0·01300 „

(*b.*) *Cashew.**—When a decoction of cashew is mixed with a solution of cupric sulphate or acetate, a liquid is obtained, after filtration, serviceable for the preparation of wood, and capable of fixing a considerable quantity of copper on the ligneous fibre. It was found, from actual experiments, that the proportions of copper so fixed are as represented in the table:—

	Grm. of Copper.
1 grm. chip prepared with cashew contained	0·0169
1 „ „ „ „	0·0135
1 „ „ „ „	0·0140
1 „ „ „ „	0·0320
1 „ „ „ „	0·0460
1 „ „ „ „	0·0145

Contrary to what might have been supposed, the use of cashew in the preparation of wood presents scarcely any practical importance. Necessitating the intervention of atmospheric oxygen, the action of cashew is limited to the surface of the wood. Chips of slender thickness and considerable size can absorb a large quantity of this substance, whilst with thick and small chips the reverse is the case.

4. *The Use of Cuprammonium Salts* allows the ready introduction of a large quantity of copper into the wood. Add to a diluted solution of sulphate of copper a quantity of caustic ammonia, or carbonate of ammonia, sufficient to re-dissolve the precipitate first formed, and to dose the metal contained in a chip plunged into this liquid for some hours. A great number of mixtures have given good results:—

	Grm. of Copper.
1 grm. of wood prepared with ammoniacal sulphate of copper	0·0166
1 ditto, ditto	0·0250
1 ditto, ditto	0·0330
1 ditto, ditto	0·0230
1 ditto, ditto	0·0423
1 ditto, ditto	0·0500
2 grms. ditto	0·0580
1 grm. ditto	0·0730

The influence this great quantity of metal exercises upon the life of wood now remains to be examined. For this purpose I buried side by side—(1) an unprepared chip, A; (2) a sulphate of copper chip, B; (3) an acetate of copper chip, C; (4) one prepared with cashew, D; (5) a chip prepared with sulphate of copper and warmed, E; (6) one prepared with acetate and warmed, F; (7) and lastly, one prepared with ammonia, G. The results are:—

	1 grm. of Wood enclosed ($CuSo_4+5H_2O$)	Wood quite destroyed at the end of
A chip	0·00002 grm.	30 days.
B „	0·00730 „	67 „
C „	0·01000 „	95 „
D „	0·01300 „	120 „
E „	0·01000 „	80 „
F „	0·02300 „	160 „
G „	0·01660 „	130 „

Numerous experiments have confirmed the above figures. Some of them are not yet completed: some chips containing 0·073 grm. of sulphate have been buried for 200 days, and are actually in a state of perfect preservation.

Among the diverse methods of preparation just noticed one alone seems to me susceptible of practical and advantageous application. The high price of cupric acetate and of indigo undoubtedly precludes their use. Heating woods injected with sulphate of copper only give results of contestable value, for the action of heat communicates a rose-colour so much the more intense as the temperature is higher; and this circumstance, combined with the relatively easy destruction of timber so treated, leads me to think that the action of heat commences an alteration in the wood by reason of the acidity of the salt, or some other cause. The use of cashew is only possible in very limited cases.

The salts of cuprammonium, on the contrary, may be employed in the generality of cases, and its minimum increase of expense will be largely compensated for by its assured long antiseptic qualities.

* A tree of the West Indies and South America, whose oil makes an enduring rust-colour on cloth.

NOTES.

The steamship *Edinburgh* will leave Portland on the 10th inst., carrying the shore ends of the New Zealand cable, and the *Hibernia* is expected to follow about the end of the month with about 1000 miles length of deep sea cable. On the arrival of the latter the two ships will proceed to lay the cables, which will connect the ports of Sydney and Wellington. The total length of cable being manufactured is 1370 knots. Last week Sir Julius Vogel visited the works of the Telegraph Construction Company, and inspected every process of the manufacture, which is progressing most satisfactorily.

We learn from the *New York Journal of the Telegraph* that Mr. Elisha Gray, of Chicago, has recently exhibited his Electro-Harmonic Apparatus in the Western Union Telegraph Office, New York. In the course of his experiments Mr. Gray found that composite tones were as easily transmitted over a wire as single notes, and this discovery has led to the development of a system of multiple transmission. On the 11th of September the apparatus was tested experimentally on a wire between Boston and New York, with very satisfactory results. Four separate communications were simultaneously transmitted from Boston, and copied from four sounders by a like number of receiving operators in New York. In the main the signals were perfectly received on all the instruments, the only apparent defect being a tendency to shorten them somewhat, a difficulty which it is said can easily be

overcome. The principle of the apparatus is a very simple one:—The depression of each key sets a self-vibrating electrotome in operation, which is adjusted or tuned to vibrate at a certain rate, differing from that of any of the others, when under the influence of the electro-magnet controlled by its corresponding key. These several sets of electrical vibrations are transmitted through the circuit without interfering with each other, in the same manner that almost any number of different sets of sound waves may pass through the air without mingling. At the receiving station each instrument is so adjusted as to respond to its own special sets of waves or vibrations, without regard to others. By breaking and closing the circuit upon the transmitting electrotome, so as to form telegraphic signals, these are transmitted and taken up by the corresponding receiving apparatus. It is not easy to fix a limit to the number of different communications that may be carried on over the same wire simultaneously, either in the same or opposite directions. The marked success which attended the operation of the principle through 240 miles of line seems to promise results in the future of the greatest value.

A trial of speed in transmitting with the Morse apparatus recently took place at Boston between Mr. C. D. Stanford and Mr. W. E. Kettles. The matter sent was messages, in the regular course of business, that had been sent to Portland in the early part of the day, averaging over ten words each in the body. Each operator sent for the space of one hour, Mr. D. E. Shaw, in Portland, doing the receiving. Mr. Stanford commenced sending at 1 o'clock p.m., and at the expiration of his hour was in the middle of his 106th message. Mr. Kettles started at 2.10 p.m., and at 3.10 p.m. stopped in his 102nd message, Mr. Stanford thus winning a decided victory over his opponent. Another trial of speed with solid printed matter is proposed.

The *Oestereichische Landwirthschaftliche Wochenblätter* states that Dr. Virson, Superintendent of the Italian Experimental Silk-Farm at Padua, has discovered that the hatching of silk-worm eggs, of suitable age, may be accelerated by a period of ten or twelve days, and a yield of at least 40 per cent of silk-worm caterpillars secured, by exposing the eggs to a current of negative electricity from a Holtz machine for the space of eight or ten minutes. It is suggested that the same method might perhaps prove useful in hastening the germination of various seeds.

Sir John Hawkshaw, in his Address to the Members of the British Association at Bristol, briefly alluded to the history and progress of the Electric Telegraph, but he omitted to mention the American inventions in connection therewith. In calling attention to this omission of Sir John Hawkshaw's, the New York *Telegrapher* remarks that "this portion of his speech is as perfect a specimen of the insular egotism for which his countrymen are noted as we have seen for some time!" We are then reminded that the first practical telegraph line of any extent was built and operated in America, by Mr. Harrison Gray Dyar, in 1826, in Long Island; that the needle telegraph has been generally superseded, even in England, by the Morse system, which, to some extent, is supplemented by the printing telegraph of Prof. Hughes, an American. The duplex system of Mr. Stearns, an American, is also being generally adopted on the English and Continental lines. The fire alarm telegraph system is the invention of Messrs. Farmer and Channing, both Americans; the quadruplex has been made practical by Americans; all the printing telegraph instruments which have proved of any value are the exclusive inventions of Americans; the quotation telegraph systems; the automatic fire telegraph system, by which instant notice is given of the commencement of fires, which has proved of great importance and value, is the invention of an American; the district telegraph system, by which messengers can be summoned, policemen called, &c., has been invented and perfected by Americans; and the harmonic electric system, by which there is every reason to believe at least sixteen communications can be simultaneously transmitted through a single wire, is the invention of Mr. Gray, also an American. We are further informed that some of the first electricians of the world are also Americans; that "in no other country has telegraphy acquired such perfection in actual use or been so universally adopted and used by the people as in the United States and Canadas. More actual business is transmitted daily on a single circuit by two operators in this country than by four operators on two circuits on the English lines. Business is dribbled over the English lines slowly by means of needle telegraphs or by Morse registers, the use of which is universal there but exceptional here; and the automatic telegraph of Wheatstone gives a speed of seventy to eighty words per minute in actual business against 1200 to 1500 words per minute by the American automatic system. Only in cable telegraphy can any practical superiority be shown on the part of British electricians and telegraphers, and this arises from the fact that in the United States we have had no long submarine cables to operate. We consider it quite probable, however, that if the speed of transmission is hereafter materially increased over such lines it will be through American inventions, and had the cable telegraphs of the world centered in New York, as they have in London, we believe that our electricians would, before this time, have devised some method of transmitting through long submarine cables more than seventeen words per minute."

A recent number of the *Moniteur Industriel Belge*, states that the method of lighting the line by electricity on the occasion of the Czar's journey on the Moscow-Kursk Railway consisted of an electric light with a battery of 48 elements carried on the locomotive. The light illumined the line for a distance of 454 metres (about 490 yards) ahead of the advancing train, and was suggested by the telegraph superintendent.

We have received from M. Louis Schwendler three pamphlets, containing the results of his endeavours "to develop the mathematical theory of Duplex Telegraphy

in its most general form, with the object of determining not only the best arrangement for any particular method, but also the relative value of different methods." The method selected by him is the Bridge, the best arrangement of which he considers to be that "all the branches of the diagram, with the exception of the one which lies opposite to the line, should be equal to half the given line resistance, while the branch opposite to the line should have a resistance of one-sixth that of the given line resistance. Further, that this branch, the smallest of all, should be invariably used for re-establishing balance when disturbed." Mr. Schwendler is said to have tested his results by actual trial and experiments. A description of the method has already appeared in our columns.

ELECTRICAL SCIENCE IN FOREIGN JOURNALS.

THIS column is devoted to a list of Electrical Memoirs published in Foreign Journals. Those of importance will be either translated in full or given in abstract.)

Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, tome lxxxi., Nos. 11 and 12, September 13 and 20, 1875.

Contain nothing relating to electricity or magnetism.

Les Mondes, vol. xxxviii., Nos. 3 and 4, September 16 and 23, 1875.

These numbers also contain nothing relating to electricity.

No. 5. September 30, 1875.

The Polarity of Magnetites.—In the metamorphic rocks in the departments of Mayenne and Maine-et-Loire there are veins of very rich earthy magnetite having the appearance of black-lead when damp. If the vein runs nearly north and south, the magnetites are very freely magneti-polar. The position of the poles change with great facility; thus their reversion may be accomplished by merely placing a piece of the ore in the opposite direction for a few days. Some turns of naked wire around a piece of the mineral, and the transmission of a double current, will determine the polarity, whilst a single spark from an electric battery displaces the poles. If we cut out of the magnetite some cubes of 5 or 6 centimetres, their magnetic poles may be displaced by an electric spark and be passed successively along all of their faces and edges. The powder of these magnetites is very attractable by a magnet. Compressed into a zinc tube, it is still very magneti-polar.

Poggendorff's Annalen der Physik und der Chimie, No. 8, 1875.

Method of Determining the Conductivity of Liquids for Electricity.—Dr. Oberbeck.—(See ELECTRICAL NEWS, p. 170.)

Attraction-Time and Disjunction-Time of Electro-Magnets.—M. H. Schneebeli.—The author describes a continuation of previous experiments. He proves experimentally that the disjunction-time is altered in the same sense as the attraction-time, when the branching of the current undergoes similar changes. To measure the disjunction-time (which is the time elapsing from the moment when the circuit is opened till the armature is detached and comes back to the rest contact) a double key was used, one of the two working contacts was connected with the line, and the other with the chronoscope. M. Schneebeli shows how his experiments fully explain the deviations and erroneous results obtained in determinations of longitude, the attraction- and disjunction-times varying (with the same strength of current) according to the strength and position of branch lines. He gives, in the concluding part of his paper, a description of some of the latest improvements in Hipp's chronoscope and directions as to its use.

Construction of Lightning Conductors for Telegraph Lines.—M. Schaack.—(See ELECTRICAL NEWS, vol. i., p. 112.)

Application of Tuning-Forks in Electric Telegraphy.—M. La Cour.—(See ELECTRICAL NEWS, vol. i., p. 34.)

Electrolytic Separation of Cerium, Lanthanum, and Didymium.—Prof. R. Bunsen.—The cell in which electrolysis of the fused chloride is effected is arranged like a Grove's element; the outer vessel, enclosing in the Grove the zinc cylinder and sulphuric acid, is replaced by a Hessian crucible, which (holding about 100 c.c. of liquid) is filled with a melted mixture of equal equivalents of chloride of sodium and chloride of potassium. Instead of the zinc cylinder is one of thin sheet-iron, serving as positive electrode, with a projecting strip in one piece with it. The cylinder encloses a clay cell of best quality, containing the chloride to be decomposed; and a thick iron wire serves as negative electrode, reaching two-thirds down, with a coil of iron wire of horsehair thickness extending from its pointed extremity. The thicker wire is enclosed in a clay pipe, so that only the fine wire is in contact with the chloride to be reduced. Gas flame is unsuitable for melting the chlorides; glowing charcoal, giving no steam, is preferable. The chloride, also, mixed with sal-ammoniac and made as dry as possible, should be heated red-hot previously in a platina crucible till all the sal-ammoniac is expelled. The quantity of metal obtained depends essentially on the temperature at which the fused chloride is traversed by the current, and on the absolute intensity of the latter. Several further details are given.

Transformation of Electric Currents of Low Tension into Disruptive Discharges of Higher Tension.—M. Holtz.—Knowing it possible, with a Poggendorff lever and a number of voltameters, to transform electric currents of lower into others of higher tension (though of short duration), the author thought that, by simply changing the voltameter-plates into condenser-plates, he might transform currents of low tension into disruptive discharges, and so obtain an apparatus which, while like an induction apparatus in its action, would offer the advantage that its discharges would not suffer retardation by a long spiral. This hope was not fulfilled, for the apparatus, with galvanic elements, was inactive; but, on using another source of electricity, an influence machine, the idea was shown to be a correct one. He therefore gives an account of his arrangement.

Additional Note on a New Electric Tube.—M. Holtz.—In a new arrangement, a tube has a partition in its middle, with two pretty large openings contracting to a funnel in opposite directions. He makes another tube, furnished near the ends with two like partitions, and in such a way that one funnel of the one is prolongation of the similarly-directed funnel of the other. Each of these tubes, brought into circuit, shows the phenomena sought,—the current choosing now the one, now the other opening, as the poles are changed.

The Chariot of the Hughes Printing Telegraph; Improvements on it, and the Automatic Liberation of the Printing Axis.—M. Sack.—We give the title of this paper (sent us by the author), which lately appeared in the German edition of *Engineering*. Its nature would hardly be understood without the accompanying figures.

The traffic receipts of the Direct Spanish Telegraph Company (Limited) for the month of September amounted to £9544, as against £8238 for the corresponding period of 1874.

COMMERCIAL NOTES.

The Anglo-American Telegraph Company have advanced their tariff from 1s. to 4s. per word. The Report of this Company, adopted at the meeting on Friday last, states that the total receipts from January 1st to June 30th, including a balance of £3683 11s. carried over from the last account, amounted to 288,636, while the total expenses—including income-tax, repair of cables, and depreciation of cable stock—were £47,570. One quarterly dividend, at the rate of 5 per cent per annum, free of income-tax, was paid on the 1st of May, absorbing £87,500, leaving a balance of £153,566, from which a second quarterly dividend, at the same rate of 5 per cent per annum, amounting to £87,500, was paid on August 1st, leaving a balance of £66,066 (including £32,301 surplus cable) to be carried forward to the next account. The falling off in the traffic receipts for the first six months in 1875, as compared with the corresponding period in 1874, amounting to £67,729, is to be attributed partly to the continued depression of the American trade, but chiefly to the reduction of the tariff to 2s. per word, which came into operation on the 1st of May last. The traffic receipts of the Company for September 29th were £1070; for the 30th, £950; for October 1st, £1200; for the 2nd, £1100; for the 3rd, £460; for the 4th, the first day of 4s. tariff, £2350; for the 5th, £2650.

The Directors of Reuter's Telegram Company, Limited, have declared the usual interim dividend, at the rate of 5 per cent per annum, for the half-year ending June 30th last, payable on the 15th of October.

The Eastern Telegraph Company, Limited, announce the payment on October 14th of an interim dividend of 2s. 6d. per share, for the quarter ended June 30th last. The register of transfers will be closed from the 7th to the 14th October, both days inclusive. The Company also announce that the coupons on the Six per Cent Debenture Bonds will be paid on October 15th next, at the bank of Messrs. Glyn, Mills, and Co., 67, Lombard Street.

A circular has been issued by Mr. William Thomas Henley, telegraph engineer and contractor, who suspended payment in March last, in which he makes a proposal for a composition with his creditors of 7s. 6d. in the pound, payable in cash by three equal instalments, extending over a period of two years from the 7th inst. Power is given for all creditors proving against his estate to claim, in lieu of their composition, fully paid-up shares (value taken at par) in a company already registered under the title of William Thomas Henley and Company (Limited), providing that the said undertaking shall have purchased his assets upon terms that the circular fully enters into. It is added that payment of the said instalments is to be secured by bills of exchange drawn by Mr. Henley upon, and accepted by, the said Company.

The ordinary general meeting of the Eastern Extension, Australasia, and China Telegraph Company, Limited, is called for the 11th inst. The report states that the gross earnings for the half-year amounted to £110,754, and the working expenses, cost of repair and maintenance of cables, payment of income tax, interest on debentures, &c., to £28,473, leaving a balance of profit of £82,281. An interim dividend of 1¼ per cent, amounting to £29,962, has been paid, and it is now proposed to distribute a further interim dividend of 1¼ per cent, leaving £22,355 to be carried forward. The company's cables are working satisfactorily.

The traffic receipts of the Western and Brazilian Telegraph Company (Limited), for the five weeks ending the 1st inst., were £10,360, showing an increase of £1124 over the corresponding period of last year.

The traffic receipts of the Eastern Telegraph Company (Limited) for the month of September amounted to £30,176, against £28,208 for the corresponding month of 1874.

The traffic receipts of the Eastern Extension, Australasia and China Telegraph Company (Limited) for the month of September amounted to £18,080, and for the corresponding period of 1874 to £18,163.

The number of messages passing over the Cuba Submarine Telegraph Company's lines during the month of September was 2072, estimated to produce £2000, against 1797 messages, producing £1802, in the corresponding month of last year.

The Brazilian Submarine Telegraph Company (Limited) announce that the accounts show a profit, for the year ending June 30, sufficient to enable the directors to recommend a final dividend of 2s. 6d. per share, making, with the previous distributions, 5 per cent per annum, and carrying to reserve the sum of £40,000.

The traffic receipts of the Great Northern Telegraph Company for the month of September, this year, were 392,089 frs.; last year, 425,931 frs. Total traffic receipts 1st January to 30th September, this year, 3,186,948 frs.; last year, 3.328,040 frs.

TELEGRAPH SHARE LIST.

Amount per Share.	Name of Company.	Amount paid up.	Closing Quotations.
£		£	Oct. 6.
Stock	Anglo-American	100	69—69¼
10	Black Sea	All	2—4
10	Brazilian Submarine	All	6¼—6¾
10	Cuba	All	7½—8
10	Ditto, 10 per cent Preference ..	All	13½—14½
10	Direct Spanish	9	6—6½
10	Ditto, 10 per cent Preference ..	All	12¾—13¼
20	Direct United States Cable	All	9¼—9¾
10	Eastern	All	7½—8
..	Ditto, 6 per cent Debenture	..	104—107
10	Ditto, Exten. Australia and China	All	7¾—8¼
10	German Union Telegraph and Trust	All	7¾—8¼
10	Globe Telegraph and Trust	All	5¾—6
10	Ditto, 6 per cent Preference	All	10—10½
10	Great Northern	All	8¾—9¼
25	Indo-European	All	19—21
10	Mediterranean Extension	All	2¾—3¼
10	Ditto, 8 per cent Preference	All	9¾—10¼
10	Panama and South Pacific	2½	..—..
8	Reuter's	All	10—10½
Stock	Submarine	100	195—205
1	Ditto, Scrip	All	1¾—2
10	West India and Panama	All	2½—3
10	Ditto, 10 per cent Preference ..	All	11—12
20	Western and Brazilian	All	10¾—11¼
1000 dls.	Western Un. U.S. 7 per cent 1st M.B.	All	106—108
100	Ditto, 6 per cent	All	90—92
10	Hooper's Telegraph Works	All	3¾—4¼
50	India-Rubber and Gutta-Percha ..	All	21—23
Cert.	Submarine Cables Trust	100	95—100
12	Telegraph Construction	All	22½—23½
100	Ditto 7 per cent Bonds	All	..—..

PATENTS.

APPLICATIONS FOR LETTERS PATENT.

3340. John Crisp Fuller and George Fuller, both of Fenchurch Street, London, for an invention of "A new or improved galvanic battery, applicable to telegraphic and other purposes."—Dated September 24, 1875.

3343. Charles Douglas Norton, of 17, Arthur Road, Stoke Newington, Middlesex, and James Grieve Lyle, of 57, Bishopsgate Street Within, London, for an invention of "A new and improved method of telegraphic communication by an hydraulic or pneumatic apparatus."—Dated September 24, 1875.

3354. Frederick Rooke, of 22, George Street, Stonehouse, Devon, for an invention of "Improvements in intensifying coils and contact-breakers for electric circuits."—Dated September 25, 1875.

3364. William Robert Lake, of the firm of Haseltine, Lake, and Co., patent agents, Southampton Buildings, London, for an invention of "Improvements in magneto-electric machines."—A communication to him from abroad by Jim Billing Fuller, of Brooklyn, New York, and

John Newland Crandall, of Norwich, Connecticut, both in the United States of America.—(Complete Specification.)—Dated September 25, 1875.

3374. John Muirhead, jun., of Stanley Villa, Thornton Hill, Wimbledon, Surrey, for an invention of "Improvements in electric telegraphs."—Dated September 27, 1875.

NOTICES TO PROCEED.

1800. John Faulkner, telegraph engineer, of Manchester, Lancaster, has given notice in respect of the invention of "Improvements in electrical appliances."

PATENTS

ON WHICH THE STAMP DUTY OF £50 HAS BEEN PAID.

2827. Charles James Adolph Dick, of Pittsburgh, Pennsylvania, U.S.A., and George Alexander Dick, of Cannon Street, London, for an invention of "Improvements in the manufacture of wires applicable to telegraphic purposes."—Dated September 25, 1872.

LETTERS PATENT FOR INVENTIONS WHICH HAVE BECOME VOID,

BY REASON OF THE NON-PAYMENT OF THE ADDITIONAL STAMP DUTY OF £100, BEFORE THE EXPIRATION OF THE SEVENTH YEAR FROM THE DATE OF SUCH PATENTS.

2929. Arthur McNutt Wier and Marshall Arthur Wier, both of Elm Lodge, Newton Road, Bayswater, Middlesex, for an invention of "Improvements in pneumatic apparatus employed in transmitting motive power for signalling and indicating, or for other purposes."—Dated September 24, 1868.

ABSTRACTS OF SPECIFICATIONS.

Improvements in electro-magnetic signalling apparatus. William Nickson Haggard, of the firm of Haggard Bros. and Co., tea merchants, 3 and 4, Fowkes Buildings, London. March 18, 1875.—No. 995. The chief feature of novelty in this invention is the employment of a rotatory or revolving electro-magnet as the motor power for actuating the signals to indicate "safety." Another novelty is the employment of a swivel shaft, carrying a free wheel and sliding toothed piece, a notched segment, and gear for controlling the signals, substantially as described in the Provisional Specification. Novelty is also claimed for the combination of contrivances which I employ for putting the rotatory magnet in action during the proper interval. But I consider that this invention should properly be regarded as a complete apparatus, the essentials of which would be as follows:—The signals which constitute one set are controlled by a swivel shaft working in a receptacle near the line. This shaft is influenced by springs or gravity to turn so as to put the signals to "danger." The shaft carries a freely axled wheel and a sliding toothed piece so worked by simple mechanism that, when the shaft has put the signals to "danger," the sliding toothed piece engages with a toothed portion of the wheel; and, when the shaft has put the signals to "safety," the sliding piece is disengaged from the wheel. This wheel is driven by a small cog-wheel, screw, or band-wheel, attached to the spindle of a rotatory electro-magnet, which upon revolving under the influence of electricity winds up the shaft so as to put the signals to "safety." The shaft is retained in "safety" position by a projecting catch entering a notch in a segment attached to the shaft. The fulcrum rod or axis of the lever segment which carries the projecting catch protrudes from an orifice in the receptacle, and is furnished with a rail lever or treadle, to be depressed by the wheel of a passing train. Contact in any electric wires is broken in this receptacle while the catch is in the notch, but is made and maintained when the catch is not in the notch. When the signals ought to be put to "safety" the following events occur:—The train wheels depress a second lever, which turns a fulcrum rod which enters a second receptacle connected with the first receptacle by the electric wires. The turning of the fulcrum rod causes the approach of an armature to an electro-magnet, and completes the circuit of the wire or wires.

Improvements in signalling on railways. Camillo Bondi, of Trieste, Austria. March 24, 1875.—No. 1075. This invention consists in improvements in electric signalling on railways, whereby communication is effected between a moving train and the stations between which it is moving; also with the signal-boxes, and with the train before and behind on the same line of rails; and at each station, signal-box, and train in motion is placed an instrument for indicating by means of hands the motion and speed of each train.

PATENTS GRANTED IN FOREIGN STATES.

FRANCE.

106,372. Edard, for "Electro-magnetic apparatus and their application."—Dated January 7, 1875.

106,397. Chutaux, for "An electric chime."—Dated January 12, 1875.

106,409. La Cour, for "Improvements in transmitting and printing telegraphic messages, and in apparatus therefor."—Dated January 13, 1875.—(English patent, Sept. 3, 1874.)

Certificates of Addition.

106,013. Brown, for "Improvements in apparatus for the transmission of telegraphic messages."—Dated January 6, 1875,

104,379. Lontin, for "Dynamo-electric machines for obtaining alkaline, earthy alkaline, and other metals."—Dated January 6, 1875.

AUSTRIA.

16. T. Chutaux, of Paris, for "A galvanic element."—3 years. (Secret.)—Dated May 17, 1875.

50. F. Krizik, of Pilsen, for "An electro-magnetic block-signal."—1 year. (Public.)—Dated May 17, 1875.

92. G. Schinka and E. Wensch, of Vienna, for "A dial and type apparatus for private and military telegraphs."—1 year. (Public.)—Dated May 28, 1875.

PRUSSIA.

31. F. von Fellinger, of Vienna, and A. Crespin, of Paris, for "An apparatus for receiving messages on pneumatic telegraphs."—3 years.—Dated August 28, 1875.

Patent Cancelled.

3. E. B. Lias, of Rio de Janeiro, for "An electric clock."—Dated May 29, 1874.—Cancelled August 19, 1875.

UNITED STATES.

166,094. *Receivers for Electro-Harmonic Telegraphs.* Elisha Gray, Chicago, Ill. Filed June 28, 1875.—The combination, substantially as set forth of the vibrating receiving spring, the elbow lever circuit interrupter and mechanism, substantially such as described, for adjusting the rate of vibration of said lever.

166,096. *Electric Telegraphs for Transmitting Musical Tones.* Elisha Gray, Chicago, Ill., assignor of one-half his right to Samuel S. White, Philadelphia, Pa. Filed January 19, 1875.—Uses induced current. By any suitable circuit-breakers pulsations are sent upon the line, corresponding in number to the vibrations necessary to produce any given note or sound. At receiving station operator is placed in circuit, and in electrical connection with a vibrating resonant plate, also in the circuit. The transmission, then, of these vibrations through the living tissue to the resonant substance causes an audible note, corresponding to vibrations sent. 1. The hereinbefore described art of transmitting musical impressions or sounds telegraphically, by producing musical impressions or sounds at the transmitting end of a telegraphic circuit by causing interruptions in the electric currents of sufficient frequency to produce musical tones, transmitting said tones through an electric circuit composed in part of animal tissue, and reproducing them at the receiving end

of the line by means of a resonant body, which is also a conductor of electricity, substantially as set forth. 2. The electro-harmonic telegraph apparatus, hereinbefore set forth, consisting of the combination of a telegraph circuit composed in part of animal tissue, a circuit-breaker capable of producing a musical tone, and a resonant conductor of electricity capable of reproducing that tone at the receiving end of the circuit. 3. The combination, substantially as hereinbefore set forth, of a telegraphic circuit composed in part of animal tissue, a resonant receiver, which is also a conductor of electricity, a series of circuit-breakers capable of producing musical tones of different pitch, and a corresponding series of keys for throwing the circuit-breakers into or out of operation, whereby several tones simultaneously may be transmitted through a single wire.

166,168. *Automatic Telegraphs.* Sir Charles Wheatstone and J. M. A. Stroh, London, England. Filed March 16, 1875.—The means for sending a weak current into the line at the end of a dash or space, for preventing an undue elongation of short currents, consisting of the lever K, operated from the transmitting levers, the contact-points F E, and the resistance and branch circuit, substantially as set forth.

166,169. *Magnets for Electric Telegraphs.* Sir Charles Wheatstone and J. M. A. Stroh, London, England. Filed March 16, 1875.—The combination, with an armature pivoted between and acted on by two electro-magnets or coils, of a spring and means for adjusting the tension thereof, and causing it to exert its force upon either side of the pivotal bearing of the armature, substantially as set forth.

166,304. *Electric Gas-Lighting Apparatus.* Frank V. Sandford, Chelsea, Mass. Filed July 14, 1875.—The combination, with an electrical gas-lighting apparatus, of a time-registering mechanism, substantially as herein described for the purpose specified.

166,305. *Telegraphic Circuits.* Wm. E. Sawyer, Washington, D.C. Filed June 19, 1875.—1. The method of operating a line of telegraph, consisting in placing the transmitting battery at or near the receiving end of the line wire, and effecting the record or actuating the receiving instrument by making and breaking the line-wire circuits at the transmitting end, whereby the battery current passing through the receiving instrument is alternately equally or unequally divided, and restored to its normal strength or required maximum value, as set forth. 2. The method of operating a line of telegraph, consisting of the employment of two circuits, the line-wire circuit and an artificial line circuit, in the latter of which is placed the receiving instrument, which is actuated, or in which the record is effected, by causing an increment and decrement, through breaking and making the line-wire circuit of the quantity or force of the battery current flowing in the artificial line circuits, as set forth. 3. The artificial circuit at the receiving end of a line of telegraph, in which the battery current flows at its required maximum of quantity or force, excepting when a greater or less portion of the battery current is diverted into the line wire by establishing the line-wire circuit, as set forth. 4. The method of effecting a record at the receiving instrument, or of actuating the receiving instrument, consisting in wholly or partially short-circuiting the main battery, which is placed at the receiving station, by wholly or partially diverting its current from an artificial circuit into the line-wire circuit.

166,431. *Electro-Magnetic Engines.* Alexander Tittman, Chauncey, assignor to himself and Henry S. Daggett, Lafayette, Ind. Filed April 15, 1875.—1. In combination with an unequal number of magnets and armatures, arranged, respectively, on a stationary cylinder and a revolving disc, a stationary ring provided with a series of keys and plates corresponding with a number of magnets and a revolving disc provided with a series of recesses corresponding with the number of armatures, substantially as and for the purposes set forth. 2. In an electro-magnetic engine, the combination of the bell-crank-shaped keys k^1 k^2, &c., plates P^1 P^2, &c., springs *s s*, and central disk provided with recessed edge, all arranged to operate as set forth.

166,471. *Governors for Electric Motors.* Augustus McConnel, Cambridge, Mass. Filed April 15, 1875.—The combination of the rotatory electro-magnetic engine, the circuit closer K having projecting arms *a a*, the slotted arm D upon the shaft S of the motor, and the conical pendulum H, constructed and operating substantially as and for the purpose set forth.

166,488. *Induction Coils.* Jos. C. Vetter, New York, N.Y. Filed August 27, 1874.—1. The handles E E′, constructed to telescope and to pass over the exterior of the induction coil through an opening in the box, substantially as herein set forth. 2. The elastic ball like attachments F F, in combination with the handles E E′, and conductors, substantially and as for the purpose specified.

166,527. *Electro-Magnetic Engines.* C. A. Hussey, New York, N.Y. Filed May 15, 1875.—1. In electro-magnetic engines, the stationary magnets having radial arms with T shaped ends, being arranged in alternating position, so that the pole ends of one face the intermediate space between the pole ends of the other, for the purpose set forth. 2. The outer stationary magnets having widening pole ends of T shape at right angles to the arms, substantially as described. 3. The central revolving magnet provided with widening pole ends of double T shape at right angles to the radial arms of the same, as set forth. 4. The stationary and revolving magnets having radial arms and widening pole ends whose face width is somewhat larger than the distance between two adjoining pole extremities, so as to lap on the pole ends across the intermediate space, substantially as described.

166,557. *Electric Railway Signals.* David Rousseau, New York, N.Y., assignor, by mesne assignments, to William F. Smith and Samuel Samuels, same place. Filed July 21, 1875.—1. The combined index and clapper E, arranged between two gongs or sounders, F and G, substantially as and for the purpose herein shown and described. 2. The lever H, pivoted to the index clapper E, and combined with the armature lever, to transmit the motion of the armature to the index clapper, substantially as herein shown and described. 3. The pins or projections *h* and *i*, applied to the vibrating index clapper E, and combined with the springs *j* and *k*, substantially as herein shown and described. 4. The annunciator I, combined with the vibrating index clapper E, and with the gongs or sounders F G, substantially as herein shown and described. 5. In combination with the vibrating index clapper E, the insulated plate J and conductor prongs or springs *r s u v*, &c., substantially as herein shown and described.

166,558. *Circuit Closers for Railroad Signals.*—David Rousseau, New York, N.Y., assignor, by mesne assignments, to William F. Smith and Samuel Samuels, same place. (Filed July 21, 1875.)—1. The combination of the tube H, formed on the circuit closer, with the inner rings or plates *h i*, and with the sliding sleeve or plate *l*, substantially as described. 2. The rod I, placed within the cushion C, and through the rings *i h*, and combined with the sleeve *l* and plate B, substantially as and for the purpose specified. 3. The cushion C, flanged on top and bottom, and combined with the plates B and D, and screw rings E and G, substantially as set forth. 4. The conductor F_b, carrying the plate *q*, combined with the conductor F_a, carrying the plate *p*, and with the cushion *r* and screw *s*, substantially as and for the purpose specified. 5. The combination of the upper and lower movable plate *h i* with the intermediate plate or sleeve *l*, which is capable of motion, all arranged to constitute a circuit closer, substantially as specified.

166,559. *Electric Railway Signal.*—David Rousseau, New York, N.Y., assignor, by mesne assignments, to William F. Smith and Samuel Samuels, same place.

(Filed July 21, 1875.)—Improvement on his patent No. 141,387. 1. The trigger, *f*, pivoted to the armature lever F, and combined with the lug *d*, that projects from said armature lever, substantially as and for the purposes shown and described. 2. The projecting hook *w*, attached to the armature lever F, in combination with the projecting stop *x* on the arm *b* of the signal, substantially as and for the purpose specified. 3. The friction rollers *u v*, combined with the projecting arms *g h* of the signal shaft, and with the springs p^a, q^a, r^a, s_a, &c., substantially as and for the purpose described. 4. The slide H, carrying the slotted arm *y*, and combined with the rope E, which has the knot *z* for the purpose of raising said slide, as specified.

166,606. *Electro-Plating Glass, China, &c.*—Eilev Hansen, Copenhagen, Denmark. (Filed Jan. 9, 1875.)—The herein-described process of forming a metallic covering on glass and like substances, consisting in first painting the surface with a solution containing sulphur, then baking or burning the article to drive off the sulphur and other volatiles and to fix the metallic base thereon, and finally making a deposit by the electro-chemical process, all substantially as specified.

166,616. *Electric Train Telegraphs.* H. C. Keyes and J. P. Clark, Philadelphia, Pa. (Filed June 9, 1875.)—1. In an electric signal apparatus for railway trains, consisting of an open metallic circuit, two wires and an interrupting bell-magnet, the plate B, with post C, in combination with the arm *a* and link E, and with the eye F of the insulating cord, substantially as and for the purpose set forth. 2. In an electric signal apparatus for railway trains consisting of an open metallic circuit, two wires and an interrupting bell-magnet, the hinged arm H and spring J, in combination with the plate *f e*, and with the eye G of the insulating cord. 3. In an electric signal apparatus for railway trains having an open metallic circuit, which, when the train is ruptured, will be closed, the hinged arm H, with point L, in combination with the plate B with point L', substantially as and for the purpose set forth. 4. The eye F of the insulating cord *c*, in combination with the link E and spring *b*, substantially as and for the purpose set forth.

Re-issues.

6575. *Hotel Annunciators and Fire-Alarms.* Edward A. Hill, Chicago, Ill. Patent No. 114,007, dated April 25, 1871. Filed July 19, 1875.—Numbers left unpainted on an opaque ground, tilting-shields same colour as ground normally behind the numbers, practically concealing them until withdrawn by magnet. 1. The combination of the pivoted armature O and tilting-blinds or curtains R, when constructed and operating in an annunciator, substantially as and for the purposes specified. 2. The dial S', provided with transparent figures, in combination with the shifting blind, as and for the purpose as specified. 3. The slide-bar V, for restoring the curtain or blind R, or the pivoted armature O, as described.

6576. *Hotel Annunciators and Fire Alarms.* Edwin A. Hill, Chicago, Ill. Patent No. 114,007, dated April 25, 1871. Filed July 19, 1875.—1. The combination of the magnet A and shunt with the special magnets B' C', when so constructed and arranged that the electric current passes alternately through the magnet and shunt automatically, for the purpose of strengthening the currents to the magnets B' C' when the magnet A is shunted. 2. The permanent magnet K', in combination with the shunt circuit and the alarm bell, when constructed and arranged substantially as and for the purposes specified. 3. The combination of the permanent magnet K', the vibrating arms L', E', and A', when constructed and arranged substantially as described, for the purposes of opening and closing the circuit of the shunt.

6577. *Hotel Annunciators and Fire Alarms.* Edward A. Hill, Chicago, Ill. Patent No. 114,007, dated April 25, 1871. Filed July 19, 1875.—The combination of the thermostat and call-key or knob in a circuit with an electro-magnetic annunciator, as described.

6578. *Electric Signalling Apparatus for Railways.* Frank L. Pope, Elizabeth, assignor to himself; Jas. N. Ashley, Greenville, N. J.; S. C. Hendrickson, Brooklyn, N. Y.; and James D. Lincoln, Greenville, N. J. Patent No. 130,941, dated August 27, 1872. Filed July 23, 1875.—1. A semaphoric signal constructed with discs or targets of alternate contrasting colours, in combination with an electro-magnet, substantially as specified. 2. An electro-magnet actuated partially or wholly by axial magnetism, in combination with a semaphoric signal, substantially as and for the purpose described. 3. An electro-magnet having an armature so arranged as to be held in contact with its poles by residual magnetism until released by an opposing or demagnetising current emanating from any suitable apparatus for generating electricity, in combination with a semaphoric signalling apparatus or an alarm, substantially as specified. 4. The combination of a semaphoric signal operated by electro-magnetism, and a secondary signal actuated or controlled by said semaphoric signal, with a reversing or releasing apparatus so arranged that when the said signals have been set by an operator at one point or station they can only be reversed or released by an operator at another point or station, substantially as herein specified.

6579. *Electric Signalling Apparatus for Railways.*—Frank L. Pope, Elizabeth, assignor to himself; Jas. N. Ashley, Greenville, N. J.; S. C. Hendrickson, Brooklyn, N. Y.; and James D. Lincoln, Greenville, N. J. Patent No. 130,941, dated August 27, 1872. Filed July 23, 1875.—1. The combination, with a visual signal, of an electro-magnet and an armature operating to display the signal by direct magnetic attraction, and to hold the same displayed by residual magnetism, substantially as set forth. 2. The combination, with a visual signal, an electro-magnet, and armature operating to display the signal by magnetic attraction, and to hold the same displayed by residual magnetism, of a circuit closer and opposing circuit for throwing a releasing or demagnetising current through the coil or coils of the actuating electro-magnet, substantially as set forth.

6581. *Electric Anuunciators.*—George W. Shawk, Cleveland, Ohio, assignor, by mesne assignments, of part interest to C. F. Uhl, John Gribben, H. A. Crossley, and W. H. Crowell. Patent No. 139,826, dated June 10, 1873. Filed March 20, 1874.—1. In an electric annunciator, the combination of an electro-magnet with an armature, which is actuated by magnetic attraction, and retained in direct contact with the cores of the electro-magnet by residual magnetism, in connection with independent mechanism, substantially as described, whereby the armature is forced from the cores by positive mechanical action, substantially as set forth. 2. In an electric annunciator, the combination of a numbered or lettered plate with the armature of an electro-magnet, the armature adapted to be retained in direct contact with the cores of the magnet by residual magnetism, substantially as described. 3. In an electric annunciator, the combination of a weighted arm with the armature of an electro-magnet, to which a lettered or numbered plate is secured for the purpose of counter-balancing the weight of the said plate, and thereby insure the attraction of the armature to the magnet by a light electric current, substantially as described. 4. In an electric annunciator, the combination of a crank shaft, having an arm secured thereto, with the armature of an electro-magnet, to which a lettered or numbered plate is secured for the purpose of releasing the armature from the electro-magnet, and allow the letters or numbers to move away from view, substantially as described.

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THE ELECTRICAL NEWS

AND

TELEGRAPHIC REPORTER.

EDITED BY WILLIAM CROOKES, F.R.S., &c.

TO ELECTRICIANS EVERYWHERE.

Since the day when Electricity was first discovered, until now, its vast importance and its high destinies have grown upon the human mind. Fresh phases of its power, fresh results, new means of obtaining and governing its action, and multiplied ends to which it may be turned, have constantly discovered themselves; till to-day it stands out as one of the grandest subjects presented to the scientific and practical world for investigation and research. Perhaps, however, no other Science or Art has exhibited so extraordinary a concurrence of anomalies. It is at once the most terrible monster and the most humble and obedient servant, its action is at one moment beneficial, at the next destructive; its range is boundless, yet it may be "cabined, cribbed, confined" at ease; it is everywhere present, while its nature is only imperfectly understood; and, to crown all, although it is one of the most important agents in the action and the phenomena of the universe, and increasing knowledge of its applicability to the needs of our race is of the utmost importance, no direct means of ascertaining the thoughts and discoveries of its students, or of bringing them before the scientific and mechanical community, at present exist. Attempts have been made to supply this want, and journals have been started with the professed object in view of making public all that is known or can be learnt of Electricity in all its branches. But they have degenerated into unscientific records of unimportant events, and the purpose for which they were established has been lost sight of. Thus it comes that—while Engineering, Chemistry, and other Applied Sciences have all their representative recognised organs—the Electrician finds himself without any current journal from which he can learn the events which are daily occurring of peculiar interest to himself.

Such a want has now been supplied by the establishment of the Electrical News and Telegraphic Reporter. In its columns will be found the most valuable opinions of eminent Electricians and scientific men all over the world. Articles will be contributed which will be of value not only to those who study Electricity as amateur experimentalists or scientific inquirers, but also to those whose daily life is bound up with the advancement of practical knowledge in all departments of the science, and who as electricians, telegraphists, electrotypers, electroplaters, and chemists have continually to deal with the same marvellous agent of force in different ways. Nor will the doings of foreign societies be ignored as in times gone by, but, in the shape of carefully prepared abstracts, their proceedings will be presented to our readers. Every opportunity will be given for the healthful discussion of the science in all its branches, and a fair unbiassed course will be steered in all questions of dispute.

This, then, is our Programme in brief. More we could promise, but prefer to let the new periodical speak for itself. The subject with which it will deal is of too great importance to need one word of recommendation. Daily experience teaches us that we are as yet on the threshold only of a vast expanse of electrical knowledge. This has to be explored, and as the research gains in strength and intelligence the results will be far beyond all present conception. The feat of girdling the earth in forty minutes will be eclipsed by great deeds yet to be done, and if the establishment of the Electrical News and Telegraphic Reporter conduces to the hastening of this desirable end our object will have been gained, and we shall be fully rewarded.

Boy Court, Ludgate Hill, London, E.C.
July 1st, 1875.

London: Printed and Published by the Proprietor, William Crookes, at the Office Boy Court, Ludgate Hill, E.C.
October 7, 1875.

THE

ELECTRICAL NEWS

AND

Edited by Wm. Crookes, F.R.S., &c.] TELEGRAPHIC REPORTER. [Registered for Transmission Abroad.

Vol. 1.—No. 16.] Thursday, October 14, 1875. [PRICE, 4d. POST FREE, 4½d.

SECOND EDITION.

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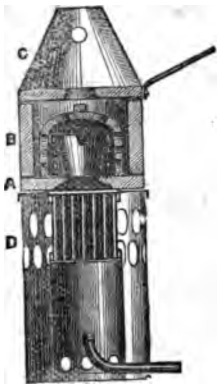

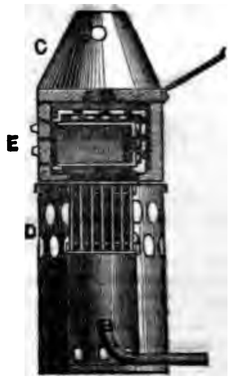

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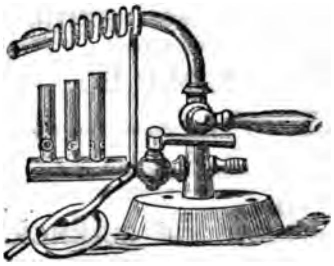

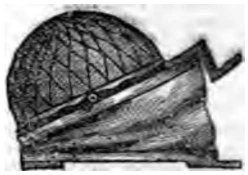

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THE ELECTRICAL NEWS.

Vol. I. No. 16.

LENOIR'S AUTOGRAPHIC APPARATUS.

The principle of this "autographic apparatus" may be explained thus:—A cylinder set in motion by a small electro-magnetic machine turns with a uniform movement at each of the two speaking stations. This electro-magnetic machine is composed of an electro-magnet and a bar of soft iron, which revolves above its poles: a regulator, independent of the apparatus, sends into the electro-magnet, at equal and close intervals, a current of short duration, whereby the movable bar is attracted at the mo nent when it approaches the poles; and its movement of rotation, whose speed depends entirely upon the current intervals, is consequently regulated. The two regulators being arranged so as to work synchronically, the period of the cylinder's revolution is the same at each end of the line.

At the sending station the despatch is written with an insulating ink upon a sheet of metallic paper, and wound around the cylinder. A metal point touches the paper, and advances with each turn of the cylinder so as to form a helix whose spirals are very near one another. When the point passes over an ink mark a positive current is sent to line; when it passes over the uninked portion of the paper a weak negative current is the result.

At the receiving station a sheet of white paper is around the cylinder, and its edges are fastened so as to form a continuous surface. An ordinary pen filled with ink is set in action by an electro-magnet. At each passage of the positive current the pen is depressed, and leaves upon the paper a mark, whose length varies as the duration of the current.

The armature of the electro-magnet is a small magnet, which is raised by the positive current, and returns to its position by the action of a spring when the current is discontinued.

Each instrument is, besides, a transmitting and receiving one. This is accomplished by means of a small chariot, which, when the cylinder turns, is urged in the direction of its axis, and carries the electro-magnet, the pen, and the metallic point. By manœuvring a small lever the pen is raised, and the style lowered to transmit; or the pen is lowered and the style raised to receive—at the same time that by a commutator the communications are reversed.

As has been said, M. Lenoir sends to line a weak negative current, which is altered to a positive one when the style passes over the insulating ink. This is effected by a very simple method, already adopted by M. Caselli in his first autographic apparatus, and applicable to all analogous ones in which the manipulator is merely intended to make and break a communication.*

The method is the use of two batteries, which call P and P_1. The negative pole of P, and the positive pole of P_1, are both in connection with the same earth. When, therefore, the style is on the insulated portion of the paper, the whole of the current from P goes to line, that of P_1 flowing to earth. But when the style is upon the uninked portion of the metallic paper the negative current transmitted by P_1 is represented by $P_1 - P$.

When we suppress this negative current by taking away the battery P_1, and by replacing it with a conductor of infinitely small resistance, the play of the armature is slower, and the apparatus does not work so well. This negative current has especially the effect of acting upon the electro-magnet of the talking station by contributing to destroy its remanent magnetism, and restoring the magnetised armature to its normal position. M. Lenoir has conceived the idea (to reduce this remanent magnetism) of winding around each branch of the coil traversed by the current a second coil, one of whose extremities is insulated, whilst the other leads to the principal wire. We do not think that this arrangement, which results in fixing the line and earth wires to an intermediate point instead of to the ends of the coils, can have a useful effect, for the supplemental coil thus added can only produce a discharge current, or an insignificant induction current.

The following is a detailed description of the mechanism of this instrument, whose size is nearly the same as the ordinary Morse receiver.

The machine comprises (1) a large horse-shoe electro-magnet; (2) a horizontal fly-wheel, to whose under surface a soft iron bar is fixed diameter-wise, and whose circumference overlaps the two poles of the shoe magnet. The vertical axis of the flywheel is a spiral which works a small horizontal shaft furnished with a pinion, *n*, and terminated by a disk *m*; (3) a copper cylinder M, upon which the receiving, or the metallic despatching paper, is wound. It is fixed upon an axis terminating in a handle at one end; at the other end is a disk so arranged as to fit into *m*, the first named disk. By this arrangement a continuous horizontal shaft from the axis of the fly-wheel to the end of the handle is obtained; and along this shaft the copper cylinder M passes backwards and forwards, being moved by sundry mechanical appliances set in motion by the fly-wheel.

At right angles to the cylinder M standing back from it, is another but smaller electro-magnet, and so placed that when the operator fronts the cylinder the poles of the magnet face him one over the o her. Between its poles a magnetised lever works, whereby an ordinary metal pen is pressed upon or raised from the cylinder. When receiving a message the ordinary metal pen filled with ink is employed; but when transmitting, the pen is removed by a kind of shunt motion, which brings a metal point into position. The former moves up and down according to the action of the current in the electro-magnet; but the latter constantly rests upon the paper, the current then not passing through the electro-magnet, but the metal point itself.

This smaller electro-magnet, together with its style, pen, &c., are fitted to a chariot, and so arranged that they can be tilted from the cylinder in order to change its paper.

The regulator, which communicates movement to the fly-wheel by means of a current passing through the large electro-magnet, is quite distinct from the apparatus already described. M. Lenoir first used a conical pendulum whose movement was maintained by clock-work. It made one revolution a second; its lower end worked in the groove of a horizontal arm furnished with a rubber, and which, by a suitable arrangement, sent four currents per second. This was replaced by an ordinary clock-pendulum, in which, to avoid frictions, the following mechanism was devised:—

The bob of the pendulum supports a permanent three-branch magnet with its poles downwards; the two outside branches are south poles, the central branch being a north pole. Immediately below this magnet is a rod hinged at one end; the other end oscillates vertically between two stops, the upper one of which leads to one of the poles of a local battery, the other pole and the hinged end of the lever rod being connected with the two branches of the large electro-magnet. The circuit therefore is (when the rod is attracted to the upper stop) from the local battery through the rod, round the large electro-magnet, back to the other pole of the local battery.

The oscillation of the lever is accomplished by means of a small bar-magnet being attached to the centre of the lever with its south pole uppermost. When the pendulum moves this small magnet is attracted at the moment

* This is not the same in ordinary apparatus—Morse, dials, &c.—where the manipulator alternatively establishes communication with line and with the receiver of the transmitting station.

when the north or middle of the three-branch pendulum magnet passes over it.

The pendulum oscillates nearly 80 times a minute, whereby 160 currents a minute pass into the large electro-magnet, producing 80 revolutions of the fly-wheel. The gearings are so calculated that this speed corresponds to 20 turns of the cylinder, equalling one revolution in three seconds.

The battery used by M. Lenoir consists of 16 large perchloride of iron elements.

Quadruplex Telegraphy.—An occasional contributor to the New York *Telegrapher*, writing from Chicago, says:—"You will doubtless remember that in your issue of February 27th, under date of February 8th, after speaking of a drawing made of the Prescott-Edison 'Quad.,' to be explained by Mr. F. W. Jones before the American Electrical Society, I remarked, 'It is also expected that Mr. Jones will explain a new system of 'Quad.,' his own invention, which I understand worked very satisfactorily in the Western Union office here on the evening of the 6th.' After a few experiments. Mr. Jones became dissatisfied with the working of his 'Quad.,' and began making improvements on it. Just about this time some different arrangement of the wires and switch board in the office were deemed necessary, which took up Mr. Jones's time entirely, so that he had no time to devote to the improvement of his 'Quad.' until about two months ago, when he again went energetically to work. As the result of his labours he has mastered every obstacle, and has now one of the simplest and yet most perfect 'Quadruplex' ever invented. For the past three weeks it has been worked almost every day in the Western Union office here on all four sides; Chicago working with Buffalo on one side, while Detroit and Chicago worked the other end as a local wire to Buffalo, having a repeater in at that point—Detroit. Thus, one wire has been made to do the work of *six* Morse circuits between Chicago and Buffalo by the insertion of a repeater at Detroit. The circuits thus arranged have not taken as much balancing as a duplex generally does, very seldom having to be balanced after being started working in the morning, and sometimes not for several days. It is without doubt a perfect 'Quad.' Some of our best electricians in this vicinity, who have seen it work, have pronounced it such. Mr. Jones has great reason to be proud of his success. I am not at liberty at present to give your readers the *electrical points* of this 'Quad.,' but will do so as soon as I *am* at liberty.

Mr. W. C. Barney's System of Rapid Telegraphy. —In our number of the 16th of April last we made mention of a new system of rapid and simultaneous telegraphy, the invention of Major Barney, an American, which had been tried on the Government lines and found to give very satisfactory results. Since that time, agreeably to Mr. Barney, some modifications have been made in the system by Mr. Godener, a Frenchman, and pupil of Bréguet, and later experiments have given still more satisfactory promise than those made at first. The following are some of the results:—On the 1st of July, the same dispatch was transmitted simultaneously to Ostend and Antwerp from Brussels, with a velocity of 600 words a minute. These trials took place on the lines between Brussels and Ostend and Brussels and Antwerp, the lines having been joined at Brussels in order to obtain increased length of circuit; the first was 156 miles, and the second about 57 miles long. July 17th, messages were sent from Ostend to Brussels with a velocity of 1092 words per minute (all being read by the employés present). August 25th, messages were transmitted from Brussels *via* Arlon and back, a distance of about 237 miles, at a velocity of 600 words per minute and read by the employés of the office. There is reason to congratulate the railroad, post and telegraphic administration for having, in the interest of science and progress, placed their lines at the disposal of the experimenters.—*L'Indépendance Belge.*

NEW SYSTEM OF OPTICAL TELEGRAPHY.

By A. LEARD.

I AM engrossed with a very important question, which to this day has not been answered:—"How to enable two stations optically to speak at great distances, whatever obstacles may arise between them."

Hitherto it has been essential that the two extreme offices should be in sight of one another. But if a wood, a mountain, or any object whatsoever, interpose itself between the talkers, speaking to another by visual signs becomes impossible.

The trial of a new method of transmission has been made at Algiers by the orders of the Governor-General. The instruments used, and the manner of carrying out the experiments, are as follows:—

Fifty large size Bunsen elements, arranged for "quantity," supplied the voltaic arc, which was regulated automatically by one of Serrin's apparatus. This was placed upon a movable platform, allowing the projected rays to sweep all round the horizon. The angle at which the luminous cone could be thrown upwards or downwards was obtained by means of a movable parabolic reflector. The manipulation was effected by means of a most elemental obdurator, composed of a simple wooden disc with a handle, and held in the hand. With this instrument the light was thrown up to 40° or 45° for a longer or shorter time, representing thus the dots and dashes of the Morse alphabet.

A mountain more than 200 metres high was situated between the observer and the luminous source. All the despatches transmitted in the manner just described were read perfectly, and sent back in the text. The sky was dark and slightly misty. The projected cone had all the appearances of a most beautiful comet's tail. At Fort National twenty-five leagues distance from Algiers, as the crow flies, the long and short intervals were very distinct. We renewed the experiment in very dry weather, and in the moon's light, as expected, the results were not so favourable. Some fugitive gleams were seen with great difficulty at 100 kilometres, so that telegraphic communication was impossible. On sea, where the upper strata of the atmosphere are always damp, I think that, even in a clear sky illuminated by the moon's rays, the signals might be read at ten or fifteen leagues distance.

Altogether, it is desirable that intercommunication should be effected under all analogous circumstances. I have ascertained conclusively that the voltaic arc, seen directly through red glass, is perceptible to a very great distance; but that the luminous beam traversing this same glass ceases to be visible at a very short range.

Now I propose, in order to solve this difficulty, to colour the voltaic arc itself by means of nitrate of strontium powder, or filings of a suitably selected metal. Nitrate of strontium gives a magnificent purple shade. Being very volatile, it need only be used as the requirements of transmission necessitate. I have thought of a small apparatus which will give this result, and a manipulator which will only produce the electric light at the moment when a dot or a dash is to be signalled. In the Morse transmission it is quite needless to have a permanent luminous cone, since the rays are only intermittingly required.

This new style of transmission may be rendered more practical by replacing Bunsen's battery with one of Gramme's machines. The Serrin regulator may be retained; but the obturator should be replaced by a disk fixed to an upright support returning automatically to its normal position by its own weight or by a spring.

This species of correspondence, "cloud-illumination," may have important applications, and notably in navigation, for it solves an important problem:—

"To light up the horizon in all directions so as to guide ships. Moreover, to secure telegraphic correspondence between vessels, buildings, and outposts in all weathers and notwithstanding intervening objects."

Two ships separated by a promontory or placed below the horizon may by this method communicate with one another. Boats forming a squadron could thus be marshalled about by the admiral's ship. These ideas represent some of the applications of this method of telegraphy; numerous others will involuntarily suggest themselves.

IRON TELEGRAPH POLES.

When the progress of telegraphic extension rendered it necessary to construct long ranges of lines through the semi-civilised regions of India, Central Asia, Australia, and South America, where it is often difficult and even impossible to procure suitable timber for poles, or where the peculiarities of climate insured the speedy decay of wooden poles, even if it were possible to make use of them, the economy of using iron poles became so apparent as to scarcely require discussion. When we consider the difficulties of transportation, labour, and maintenance, in these partially civilised countries, inhabited by a rude and scattered population, and compare the relative first cost and duration of wooden and iron poles under such conditions, the saving which must result from the employment of the latter is readily seen. But in the more thickly settled countries of the world, where transportation is abundant and cheap, and the cost of inspection and maintenance is comparatively low, the question of relative economy becomes a much more complicated one. It is not proposed to enter into an extended discussion of the relative cost and advantages of iron and wooden poles, for the reason that so many different considerations enter into the question that perhaps nothing short of a somewhat lengthened experience with both systems of construction under corresponding conditions would enable results, even approximately correct, to be arrived at.

One of the earliest inventors who turned his attention to the subject of iron poles was that eminent telegraphic engineer, C. W. Siemens. Considering that the object in view would be most completely met by a design which should combine lightness and convenience of construction, with the maximum degree of stability and resistance to sudden strains, as well as to oxidation, he was led to abandon the ordinary method of securing poles by setting a considerable length of them in the ground, and to make use of a horizontal wrought-iron foot-plate buckled or corrugated into the form of a shallow or inverted dish, which combines a great degree of rigidity with a peculiar toughness which enables it to yield without injury to sudden and excessive strains. The portion of the post which is partly buried in the ground, and is therefore exposed to the action of moisture both from the earth and the atmosphere, is made of cast-iron, and is of a tubular form. This tube is fastened to the foot-plate by four bolts, and is provided at its upper end with a socket for the reception of the upper tube. The latter, which forms the principal part of the pole, above ground, is made of wrought-iron. The upper tube is cylindrical for a distance of about 2 feet above the socket, and from thence tapers gradually to the top. This form ensures a distribution of metal, which, with a minimum expenditure of material, gives a maximum degree of rigidity or resistance to a horizontal strain. The upper and lower tubes are cemented together by means of a fused mixture of sulphur and oxide of iron.

The height and dimensions of these poles vary according to circumstances. If only one or two wires are required, and economy is an object, poles having a total length of 19 feet 8 inches are used, standing 17 feet above the ground when in position, it being usual to place the post 2 feet 8 inches in the ground. The total weight of such a pole is 184 lbs., and, as it may be transported in three separate parts, the weight of the heaviest piece will be less than 100 lbs. At all points where the line is exposed to an extraordinary strain, a heavier pole, weighing 295 lbs., is made use of. For a heavier class of lines a larger-sized pole is made, weighing 254 lbs., with extra poles weighing 340 lbs. The ordinary number of poles to a mile is about twenty-one.

Iron poles of this description were first erected by the firm of Siemens Brothers, in Spain and South Africa, as long ago as 1863. Since that time more than 180,000 of these poles, representing over 9000 miles of line, have been erected in New Zealand, Ceylon, India, Egypt, Persia, Russia, Mexico, Brazil, the Argentine Republic, Chili, and Peru, and are said, in all cases, to have remained in perfect working order ever since their erection.

As a rule the Siemens poles are estimated to cost from two to three times as much as good wooden poles of corresponding strength,—say from 6·50 to 17·50 dollars each, according to size and strength.

In many countries, however, where both wooden and iron poles would have to be transported over great distances, by such means as are usually available in half-civilised countries, iron poles become as cheap as wooden ones at the point of erection, owing to their weight being so much less, and their transportation so much easier, on account of being carried in pieces of convenient weight and bulk. It will, therefore, be readily seen that in tropical countries where wood is subject to dry rot, and where wooden poles have to be renewed every few years, that the relative advantages of iron poles of this description are very great indeed. In civilised countries, however, the advantages to be gained by the use of these poles instead of wooden ones is not so obvious, and we do not find that they have as yet been introduced to any considerable extent.

The rapidity with which wooden poles were found to decay, and the expense and interruptions occasioned by the continual renewal of the poles and the transfer of the lines from the old poles to the new, led the telegraphic administration of Switzerland to construct an experimental line upon iron poles, as early as 1857.

The experiment was continued in 1858, but the T iron which was employed for building the first lines was replaced by two or more cylindrical tubes screwed together by means of a threaded coupling. After an experience of three years, which served to demonstrate the fact that this manner of joining the poles did not insure a sufficient degree of rigidity, this form was in turn abandoned. After successive trials made with specimens of various designs, it was at length decided upon to use conical tubular poles formed of a single piece, as this seemed likely to fulfil all the necessary conditions.

The length of these poles varies, according to circumstances, from about 8 feet 4 inches to 24 feet 7 inches, but practically they have always remained within the limits of 11 feet 4 inches and 18 feet 8 inches. The minimum diameter measured just below the top of the pole is invariably 1·6 inches; it increases regularly towards the base in all cases, so that a pole 12 feet long has a diameter of 2·56 inches, and an 18 foot 8 inch pole a diameter of 2·95 inches, at the base. The thickness of the iron is uniformly 0·2 inch.

The poles are firmly secured in the ground by means of sockets of stone whose dimensions depend upon the length of the poles. For the small sizes these sockets are about 2 feet square. The insulator brackets are placed in round holes drilled transversely through both sides of the pole, and are fastened by iron wedges or keys.

The durability of these poles is of course almost unlimited, provided they are properly covered, from time to time, as may be required, with a coat of varnish for the protection of the iron. The results obtained in regard to the insulation are said to be not unfavourable, and the Swiss administration has had reason to be very well satisfied with this system of construction. It presents, however, one inconvenience, which could hardly have been foreseen, but which will nevertheless be somewhat difficult to remedy. This inconvenience arises from the comparatively small number of wires that these poles are capable

of accommodating. In 1861, when the system of construction with iron poles began for the first time to be used to any considerable extent, there were only some 10 miles of line in all Switzerland, having four or more wires, and it was then thought that in providing for ten or twelve wires all possible requirements would be exceeded. At the present time some of the lines built in 1861 and 1865, with iron poles, have more than fifteen wires, so that it has become necessary to duplicate the lines—a result which might have been postponed for several years if wooden poles had been employed.

The metallic posts employed by the Bavarian Administration are made of rolled iron, and are cut to three different lengths—viz., 5, 6, and 7 metres. The outline of the transverse section is the same for the three sizes—that of an H or double T.

The reason for the selection of this particular form was as follows:—In consequence of the high price of iron it was necessary to adopt a system of construction which would reduce the labour of setting the poles as much as possible, and, on the other hand, give the iron such a form as the law of strength of materials shows to be most advantageous.

As the greatest strain on the posts is not in a direction parallel to the wires, the wind not acting upon them in the direction of the tension, the most proper form for a telegraph post is therefore not that having a circular transverse section, but that in which the section resembles a double T, having its ends placed perpendicular to the strain of the wires. With this form the construction of poles is neither very expensive, nor is much additional work required in fitting them up. The cross-arms and insulator pins are also very easily attached.

After being rolled out, the poles are cut to the desired lengths, and the ends carefully filed. In the centre of the groove of each pole five holes, about 0·67 inch in diameter, are drilled, the centre of the upper hole being 7·87 inches from the top of the pole, and the distance between two holes 15¾ inches. Opposite these holes, and on alternate sides of the pole, recesses are cut out to receive the cross-arms.

In order to protect the poles from action of the elements they are carefully freed from filings and rust, washed with lime-water, and then plunged while still wet into a bath of boiling oil, after which they are covered with a coat of red-lead.

The cross-arms used with these poles are of an L form, and are composed of the same metal as the poles themselves. They are made in three lengths, viz., 2 ft. 7 ins., 3 ft. 7 ins., and 4 ft. 7 ins.

In one face of the cross arm, midway between the ends, a hole 0·67 inch in diameter is drilled; two additional holes are made in the other face of the 2-foot 7-inch arms, and four holes in the 3-foot 7-inch and 4-foot 7-inch arms. The latter holes are also 0·67 inch in diameter, and the distance between their centres and the axis of the poles is as follows:—

For the 2-foot 7-inch arms, 1 foot 4 inches.
" 3 " 7 " " 8·3 ins. and 1 ft. 8 ins.
" 4 " 7 " " 1 ft. 5 ins. and 2 ft 8 ins.

The other details for completing the arms are the same as for the poles.

The cross-arms are fastened to the poles with bolts 2¾ inches long and 0·59 inch in diameter. The heads of the bolts are 1·2 inches in diameter and 0·03 inch thick. Hexagonal nuts, 0·69 on a side and 0·03 inch thick, are used to secure the bolts: the latter should be coated with black varnish.

The pins for supporting the insulators are formed of iron rods, one end being furnished with a thread and nut.

The total length of the pins is 7·8 inches, and their maximum diameter 0·59 inch. The shoulder at the lower end is 1·2 inches in diameter and 0·24 inch thick. The hexagonal nuts are 1·23 inches on a side and 0·32 inch thick. Both the pins and nuts should also be covered with black varnish.

The sockets or stone blocks which are used in order to make the base of the pole firm and secure are of solid and fine-grained granite. They are 4 feet 2 inches high, and their section forms a square of 17·7 inches on a side. They are cut away at the top to a depth of about 3·9 ins., and the square reduced to 13·78 inches on a side. The upper surface has a slight inclination of about 1·2 inches between two opposite angles. In the middle of the upper face a hole is drilled 9·8 inches deep, and shaped like a section of the pole—that is, like a double T. This is exactly in the vertical axis of the granite block, and its outline conforms as much as possible to that of the poles, so that when the latter are introduced a great quantity of cement will be required in order to secure them firmly.

For securing the poles in the granite blocks the Bavarian Administration makes use of melted lead, as the other substances generally employed for this purpose are liable to give way, owing to the continual vibrations of the poles. The melted lead is poured into the spaces between the pole and sides of the socket until it runs over and forms a pyramid around the base, entirely covering the opening of the stone.

After having been set the poles and cross-arms are covered, especially at the base, with a thick coating of oil varnish of grey zinc, and, in order to prevent discharges of atmospheric electricity from injuring the stone sockets, each pole is provided with a No. 9 iron wire, one end of which is buried in the earth and the other end embedded in the mass of lead which surrounds the base of the pole.

The plan of construction just described is that which is employed for the line between Munich and Augsburg, a distance of 8½ geographical miles: this is the only line on which this system of poles has as yet been introduced. This line has been built three years, and has thus far required no repairs except the replacing of two of the stone blocks, which already had cracks in them before setting, although these were not then apparent. The insulation is perfect, and the leakages between conducting wires—which interfere particularly with the transmission of correspondence by the Hughes apparatus—are entirely avoided by the use of these poles. In this respect they seem to fulfil the office of large condensers.

The present very high price of iron will doubtless prove an obstacle to the use of this system of metallic poles on all the lines, but the Bavarian Admistration considers that if the prospect of this considerable expense is such as to be likely to cause much hesitation on the part of telegraphic administrations, the railroad companies will soon become convinced that it is better to increase the first cost of their railway—in order to obtain a good, substantial telegraph line—than it is to continue to employ wooden poles when their many disadvantages continually compromise the security of trains.

The two following tables indicate the weight and price of the dimensions of iron poles which have been adopted:—

Table showing the Weights of the 5-Metre Pole

Number of Pieces.	Names of Parts.	Weight in lbs. Alone.	Weight in lbs. Together.
	Forged Iron.		
1	Pole, 5 metres long	181·90	181·90
2	Cross-arms, 2 feet 7 inches long	7·00	14·00
2	" 3 " 6 " "	9·70	19·40
1	Cross-arm, 4 " 6 " "	12·35	12·35
5	Bolts	—	1·65
16	Insulator pins, complete	—	9·90
			239·20
	The weight of a 6-metre pole is		276·70
	" 7 " "		312·10
1	Granite socket	—	1448·40

Table showing the Cost of a 5-Metre Pole.

Quantity.	Names of Parts.	Cost by the 110¼ lbs. Dols.	Total Cost. Per Pieces. Dols.	Total Cost. Together. Dols.
1 Piece.	Granite block with hole	—	—	3 52
181·9 lbs.	Pole of rolled iron ..	3 12	—	5 16
45¾ „	Cross-arms of rolled iron	3 12	1 30	1 50
5 Pieces.	Bolts	04	29	
				97·5
16 „	Insulator pins, complete	06	—	—
				1 17
22 lbs.	Of lead for fastening the poles in stone	11·7	—	—
	Painting of poles.. ..	—	—	31
	Total	—	—	12 65
	The net cost of the 6-metre poles is ..			13 65
	That of the 7-metre poles			14 66

The poles weigh about 36 lbs. per metre, and carry 16 wires of about No. 7 gauge. The Bavarian Administration considers that for spans of only 145 feet, poles weighing but 22 lbs. to the metre might be used, It was thought advisable, however, not to reduce the material to its least dimensions for this line, which in reality constituted an experimental one.

Along railroads the poles most in use are those of 5 metres (16 feet 4 inches) in length, but for level crossings they are 7 metres (22 feet 10 inches) high, and both sides of the cross-arms for 6-metre poles are used. On straight lines and for curves on level ground the distance between the poles is about 145 feet.—*Journal of the Telegraph.*

COMPOUND TELEGRAPH WIRE.

Compound telegraph wire, although a comparatively new invention, has nevertheless been extensively used in the United States of America, Brazil, the River Plate, Central America, Russia, Japan, China, various European Telegraph Administrations, and also for Military Field Telegraph Service.

The results obtained by the use of this wire have in all cases been most satisfactory, on account of the many advantages it offers over the ordinary galvanised iron telegraph wire, formerly exclusiveiy employed.

The compound wire consists of a tinned steel wire of highest quality, around which a copper strip is wound helically: both steel and copper, having been drawn through a draw-plate, are firmly soldered together, and thus produce a compound wire, which combines lightness with strength and high conductivity.

The advantages of the compound wire over iron wire will appear from the annexed list, which compares the dimensions and weights of ordinary iron wire with compound wire of equal electrical conductivity, and shows the following important results:—

The proportion of weight between ordinary iron wire and compound wire of equal conductivity is about 3 to 1; that is to say, compound wire only weighs one-third of iron wire of equal electrical capacity. This light weight, when compared with the weight of an ordinary iron wire of equal conductivity, offers an advantage in constructing telegraph lines, especially in countries where the transport of the materials is expensive, as a saving of about 67 per cent in cost of transport is effected.

Expense is also saved in erecting the compound wire, as the lightness of this wire economises time and labour, and requires but from two to three joints per mile. On account of its small weight the poles will carry a larger number of compound than of iron wires, and the insulators may be of lighter and less costly construction.

A line with a given number of poles will therefore be more substantial and durable with compound wires than with ordinary iron wires. The strain and weight upon the poles, especially at curves and angles, being less, the line must necessarily stand firmer, and the smaller diameter of the wire offering less surface to the pressure of storms, to the accumulation of sleet, &c., renders the compound wire less frequently subject to temporary interruptions.

Compound wire, being a steel wire protected by a thick sheath of copper and tinned, does not corrode like iron wire—therefore is less liable to breakage. Its superiority in this respect has been tested by a series of severe experiments, in which compound wires and iron wires have been exposed to the influence of air under pressure, the air being alternately impregnated with acid and salt. The results proved that an iron wire of 4 m.m. diameter was on the ninth day partly destroyed, whereas the compound wire remained in a perfect state of preservation.

This wire is especially well adapted for military telegraph lines, and has given ample proofs of good field service. It is, further, well adapted for long spans, for crossing rivers, ravines, mountains, for overland lines in towns, &c.; and it has been found that stretches from a quarter to three-quarters of a mile can be successfully maintained.

Siemens Brothers' compound wire is said to have given satisfaction wherever used, not only from the advantages already mentioned, but also from the fact that it guarantees greater economy in the maintenance of lines, and that fewer interruptions and disturbances occur than with lines of ordinary construction.

These considerations justify a greater first outlay for material, and give the compound wire the preference, as being in the long run the cheaper material.

The table at foot shows the diameters and weights of ordinary iron wires and of compound wires of equal conductivity.

The joint consists of a flat brass tube. The two wire-ends are pushed into the tube at each end, and are opened out in the centre by a pointed steel drift. A rivet is inserted in the hole thus formed; the ends of the wires are bent round outside the tube, and the entire joint is finished by soldering.

Iron Wire. Diameter. Millim.	Iron Wire. Diameter. Inches.	Iron Wire. Weight per Statute Mile of 1760 yds. in lbs.	Iron Wire. Quantity required for 1 Statute Mile, including slack, in cwts.	Conductivity, or Electrical Resistance per Statute Mile in Siemens Units, at 59° F. (15° C.) for Iron and Compound Wire.	Compound Wire. Diameter. Millim.	Compound Wire. Diameter. Inches.	Compound Wire. Weight per Statute Mile of 1760 yds. in lbs.	Compound Wire. Quantity required for 1 Stat. Mile, including 5 per cent for slack, in cwts.	Compound Wire. Breaking Strain in lbs.
6·00	0·236	770	7·25	7·62	3·25	0·128	248	2·32	1670
5·50	0·216	645	6·00	9·07	3·00	0·118	208	1·95	1365
5·00	0·197	537	5·00	10·98	2·75	0·108	173	1·62	1120
4·50	0·177	433	4·10	13·56	2·50	0·098	142	1·33	920
4·00	0·157	341	3·25	17·14	2·25	0·089	114	1·07	742
3·50	0·138	264	2·50	22·40	2·00	0·079	88	0·82	600
3·00	0·118	193	1·84	30·48	1·75	0·069	65	0·61	458

In working automatic, duplex, multiplex, or chemical telegraphs at high speed, a great obstacle to rapidity of transmission arises from the fact that the lines become surcharged with an induced current, the result being that a discharge continues at the receiving end of a line after the battery circuit of the transmitting station has been broken. A "tailing" is thus produced, which in rapid writing fills the spaces between the letters, the result being a long indistinguishable dash or line. Interference is greater on wires worked with double currents than when worked with single currents. There is thus with the employment of iron wires a limit to rapid telegraphy on aërial lines. This inductive interference between suspended wires increases with the *diameter* (upon which depends the *surface* and *inductive capacity*) of the wire, and decreases with increase of distance between the wires themselves. As crowded poles do not allow of increased distance between the suspended wires, it is necessary, in order to facilitate the urgent requirements of rapid telegraphy, to employ wires of small diameter. The best results are obtained by the use of compound wire.

IMAGES PRODUCED BY LIGHTNING.

A letter of Professor W. L. Brown, of the University of Georgia, to the *American Journal of Science and Arts*, calls attention to a remarkable instance of the formation of impressions upon the human body by a lightning stroke, and encloses letters of Messrs. E. G. Simmons and T. N. Hawkes, of Americus, Ga., where the occurrence took place, describing the circumstances and some of the details of the phenomenon.

On the 12th of July, 1875, at about 4 p.m., as Mr. Simmons states, a stroke of lightning fell upon a house in Americus, rendering insensible for a time four persons who were seated in one of the rooms. The two outer sides of this room, which was at a corner of the house, had each one window, and nearly opposite these on the two other sides were the chimney and the door respectively. Outside, a tree stood in front of each of the windows, and about twelve feet from the house. A third tree, a locust, stood opposite the outer corner of the room and about the same distance from the house as the others. This tree was severed by the lightning, but the other two were not affected. A young child was sitting near the centre of the room, while the mother and a young lady were seated not far from the chimney, near which, and close to the wall, was another child.

All these persons were rendered insensible for a time by the stroke which severed the tree, and on their recovery there were found impressed upon the bodies of them all more or less distinct images of this tree. It was most distinct in the case of the child near the centre of the room. Mr. Simmons says, "the child is impressed upon its back and exactly opposite upon its stomach. The entire tree is plain, and perfect in *toto*; every limb, branch, and leaf, and even the severed part, is plainly perceptible. It is a perfect photograph of the tree, and could not have been made more perfect by a painter's brush. It impressed the young lady upon the left hip and right leg," the mark being quite as perfect as that upon the body of the child. The mother and other child also bore less distinct impressions upon the leg. Mr. Hawkes says, "I saw the youngest child and the marks upon it. The marks on the lower part of the spine are exactly of the shape of a branch of the locust tree. Where the leaves are, on the branch, the mark does not take the shape of the entire leaf, but only of the skeleton of a leaf. The mark was about twelve inches long, and had a fork, exactly like the locust limb. It looked as though the blood was drawn to the skin along the marked part." The marks were not permanent, as Professor Brown, in his letter dated August 7, adds, "a recent letter informs me that the impressions are no longer distinct."

Although many similar cases have been reported, the phenomenon described is rare enough to make a well-marked instance like this worthy of record. The formation of the images in all such cases is readily explained by a peculiarity in the mode of the electric discharge under certain conditions, by imitating which it is possible to produce similar figures artificially with an electrical machine, such as the Holtz machine, capable of giving electricity of very high tension. When the poles of the latter are strongly charged and are separated to the distance of a few inches, the discharge, instead of producing a spark or brush, sometimes consists of a very small jet upon the negative, and a sort of phosphorescent glow upon the positive. The space between them, though not luminous, is the seat of a discharging action which appears to take place along definite lines, like a stream or current, and is sometimes called the dark discharge. An object placed between the poles, and in the path of the discharge, interrupts this, and destroys the glow upon the positive pole in points corresponding to the lines thus broken; and in this way there is produced an image or shadow of the interposed object, which is often strikingly distinct and perfect.

In the case above described the phenomena are readily accounted for, if we suppose the thunder-cloud to have been negatively charged, and the tree to have stood in the path of the dark discharge which preceded or accompanied the lightning stroke, the action having been sufficiently intense, and the quantity of electricity great enough, to produce a visible impression upon the delicate tissues of the skin.

A more particular account of the subject may be found in two articles published in the *American Journal of Science* for May, 1870 (p. 381), and June, 1871 (p. 437).

NOTES.

Mr. J. B. Fuller, writing to the *Scientific American*, says—"A few weeks ago my watch, for the first time in ten years, refused to go. Till then it had kept correct time, and was then in good repair, having been recently cleaned. When it first began to stop I would start it by the key, and it would sometimes run a day; but finally it stopped entirely. I had it carefully examined by an expert, who, although he could find no cause, failed to make it run even for an hour. I am running at my works a powerful magneto-electric machine for depositing copper; and having noticed that I could magnetise a piece of soft iron at a distance of at least 6 feet from the machine, so that it would lift and support the weight of a large nail, I became impressed with the idea that some of the steel parts of my watch had become permanently magnetised; so I made a watch repairer take it apart. Having some fine soft iron filings, I dipped the balance-wheel, escapement-wheel, lever, and hair spring into the filings; and each piece raised up at least one-half its own weight of the filings, showing all the polar characteristics of the particles. I have read of watches being spoiled by magnets, but had no idea that it was unsafe to go into a room containing a magnet. The watchmaker thought he might "brush it off" for about a dollar: I let him brush on it three days as a lesson in magnetism, and then told him that nothing short of heating it red-hot would demagnetise it. He put in new parts, including a new mainspring, which was also infected, and the watch now runs as well as ever."

The same journal announces the death of Dr. Leverett Bradley, who died recently in Jersey city, N.J., in the 77th year of his age. For a number of years Dr. Bradley has been well known as an electrician of considerable ability; but he is best known from the invention, which he patented in 1865, for winding helices with uncovered wire. In 1859 he secured a patent for an automatic telegraph apparatus, with which, on a short circuit, he succeeded in recording about 15,000 words per hour, but he was unable to practically work the apparatus on a telegraphic line of ordinary length. In 1873 he obtained a patent for an apparatus for electric measurement, being a combination of a tangent galvanometer and rheostat, which proved very successful, and is now being much used in colleges and other institutions of learning as a means of instruction and experiment.

ELECTRICAL SCIENCE IN FOREIGN JOURNALS.

This column is devoted to a list of Electrical Memoirs published in Foreign Journals. Those of importance will be either translated in full or given in abstract.)

Journal Télegraphique. Vol. iii., No. 9. Septemr 25, 1875.

The St. Petersburg International Telegraphic Conference.—Conclusion.

Description of a Special Lightning "Protector" for Aërial Lines.—J. F. Vaes.—A metal ring about 1½ centimetres wide, and 2½ centimetres diameter, is cut in two: on one side the two ends are joined together by a hinge; on the other they are closed by means of a screw. This metal ring surrounds a hardened wooden reel, likewise divided in half, and perforated through its axis. The metal band is retained in position by the raised edges of the reel, and to its inner side a "preservative" point of aluminium bronze or platinum is fixed, which penetrates the reel to within 1 or 2 millimetres distance from the hole through it. In order to attach this "protector" to a telegraph wire, the metal band is opened, and with it the two halves of the reel. It is then placed upon the line wire, and closed by the screw so that the wire occupies the axial perforation. To the head of the screw is then fastened a gutta-percha-covered copper wire whose other extremity is affixed to a metallic plate in the post, or some other "earth." In this little device it is impossible for the "preservative" point to touch the wire; and it is, moreover, shut out from atmospheric influences. (1). The aperture of the reel should have its diameter a little smaller than that of the wire, in order that the "protector" be properly fixed. (2). To fill up the cleft that will always exist, more or less, between the two halves of the reel, place there some gutta-percha, or tarpaulin, before the reel is fastened: these materials, by compression, will entirely fill the cranny. (3). In times of thunderstorms the "protector" will give rise to derivations by reason of the small distance of the exterior surface of the band from the telegraph wire. Many means are available whereby this inconvenience may be remedied. It will be insufficient to varnish the metallic parts; it is much better to lengthen the reel, or to give greater height to the raised edges. Another means consists in covering the wire with an insulating layer for some centimetres on each side of the "protector;" but that which appears to be the most simple and efficacious is to as it were "house" the "protector," so as to protect it from the rain. (4). The construction, though based on the principles expounded, may be varied considerably, such as by replacing the single point with several points, or with a many-toothed metal plate, &c. (5). It may also be used without altering the supporting poles. One is not limited in the choice of situations, and one may thus regulate electrical discharges at convenient distances from cables and instruments, so that in case of a storm they would be found much less exposed to derivations.

General Theory of Duplex Telegraphy.—Third part.

General Statistics of Telegraphy in 1873 and 1874.

COMMERCIAL NOTES.

The report of the directors of the West India and Panama Telegraph Company, Limited, for the six months ending June 30, 1875, to be presented at the half-yearly general meeting on the 22nd inst. states that the amount to credit of revenue account is £26,130 17s. 6d., and the expenses have been £15,140 1s. 11d., leaving a balance of £10,981 15s. 7d. Out of this amount the directors propose paying 7s. 6d. per share on account of the arrears of dividend on the first preference shares, and carrying forward £1606 15s. 7d. to the next half-yearly accounts. The sum of £1875 was received during the half-year on account of subsidies. It is anticipated that further sums will be received upon the completion of the negotiations with the colonies which, when paid, will be brought into revenue account. The increase in the traffic receipts for the half-year is £9308, or 67 per cent in excess of the receipts for the corresponding period of 1874. This increase is principally due to improved service, and to the fact that receipts from the Jamaica-Colon cable, amounting to £2900, are included in this half-year's accounts. The capital account has necessarily undergone considerable alteration since the publication of the last balance-sheet, in consequence of the settlement with the India-Rubber, Gutta-Percha, and Telegraph Works Company, payments for cables completed and handed over to the Company, and other matters. The Punta Rassa-Key West cable, belonging to the International Ocean Telegraph Company, was interrupted from 1st to 13th June last, The Directors are informed that the section has now been duplicated, whereby the communication between the United States and this company's system is rendered more reliable. The Trinidad St. Croix-Ponce section of cable, stated in the last report to have been completed on the 25th of March, having been certified by the engineers, was opened by this company for traffic on the 25th of April, 1875, since which date it has continued in good working order. £275,000 in ordinary shares of the company have been paid to the Central American Telegraph Company, in terms of the agreements with them. The line of cable contracted to be laid by the Central American Telegraph Company for this company between Demerara, Cayenne, and Para, has not yet been certified by the company's engineers, and consequently has not been taken over, but an agreement has been entered into under which the cable is to be worked for a period of three months, without prejudice to any question.

The Eastern Telegraph Company (Limited), in connection with the Eastern Extension, Australasia, and China and Brazilian Submarine Telegraph Companies, state in their circular for the month of September last the latest dates of messages received in London from India, China, Australia, &c., by the direct cable route of the Associated Companies, which continued working with uniform speed and efficiency; that the average time the messages occupied in transit had been from Calcutta seventy minutes, and from Bombay fifty-five minutes. The Eastern Extension Company's cable between Singapore

and Batavia had been restored, having been interrupted for repairs during the first half of the month. The Indian Government Lines between Ahmedabad and Deesa were swept away by floods, and all communication with India and the East (excepting to Kurrachee) by the land route was in consequence interrupted from the 20th to the 28th of September, between which dates the whole of the Indian traffic passed over this company's lines.

The Submarine Cables Trust announce that the coupons for the half-year, due on the 15th inst., will be paid as usual by Messrs. Glyn, Mills, and Co. on and after that date.

The interim dividends of the Globe Telegraph and Trust Company, Limited, for the quarter ending the 18th inst., will be 3s. per Share on the Preference Shares, and 3s. per share on the Ordinary Shares, both payments being at the rate of 6 per cent per annum per share. The warrants will be payable on the 19th inst.

On Thursday, the 7th inst., a meeting of shareholders of Hoopers Telegraph Works, Limited, was held at the Cannon Street Hotel, to receive the report of the Committee appointed at the meeting held on the 23rd of last month. The Committee have been hard at work, but the figures and details to be examined and digested are so numerous that the Committee have been unable to draw up a carefully-considered report for presentation to the shareholders, and therefore the meeting was adjourned for another month. So far, however, as the Committee have gone, the facts elicited are not of a discouraging character, but, on the contrary, are of a nature to somewhat reassure those who have, since the discovery of the defalcations of the secretary, taken a pessimist view of the position and prospects of the Company. Mr. Walter Hancock, a member of the Committee, and a gentleman well known as an efficient telegraphic engineer, stated to the meeting that, from a personal inspection, he had satisfied himself that the works have been most ably laid out, and efficiently and economically constructed. He considers that, if more moderate dividends had been paid, the Company would now stand worth 20s. in the pound. The meeting, on the whole, was of an encouraging character, and one or two gentlemen ventured to express a hope that there may yet be a future for the Company.

According to the report of the Directors of the Eastern Extension, Australasia, & China Telegraph Compy., Limited, presented at the general meeting on Monday, the 11th inst., the gross earnings for the half-year have amounted to £110,754 2s. 3d. The working expenses, cost of repair and maintenance of cables, payment of income tax, interest on debentures, &c., amount to £28,473 18s. 9d., leaving a balance of profit of £82,280 3s. 6d. for the half-year. An interim dividend of 1¼ per cent, amounting to £29,962 10s. has been paid, and it is now proposed to distribute a further interim dividend of 1¼ per cent, leaving the sum of £22,355 3s. 6d. to be carried forward. The debenture debt, taken over by this Company from the China Submarine and British-Indian Extension Companies, has been reduced by £3200, leaving a balance of £4700, of which a further sum of £1500 has been redeemed since the commencement of the present half-year. By a resolution passed at the special general meeting, held on June 7th, 1875, an issue was authorised of 3200 debentures of £100 each, bearing interest at the rate of 6 per cent, for the purpose of laying the cable between Sydney and New Zealand, and the greater portion of the same has been taken up and allotted to the shareholders at par. The s.s. *Edinburgh* has left England, and the s.s. *Hibernia* will leave in the course of the present month, with the cable, which it is anticipated will be laid early in the ensuing year. The company's cables are working satisfactorily.

The traffic receipts of the Brazilian Submarine Telegraph Company, Limited, for the month of September, 1875, amounted to £9544, as against £8238 for the corresponding period of 1874.

The Submarine Telegraph Company's receipts for the month of September amounted to £10,013, being an increase of £331 over the corresponding month of last year.

The estimated traffic receipts of the Anglo-American Telegraph Company for the 6th inst. were £2600; on the 7th, £2650; on the 8th, £2500; on the 9th, 2200; on the 10th, £690; on the 11th, £2140; on the 12th, £2540, as compared with £2118, the actual daily average for the month of October last year, when the same rate of 4s. was charged.

TELEGRAPH SHARE LIST.

Amount per Share.	Name of Company.	Amount paid up.	Closing Quotations.
£		£	Oct. 13.
Stock	Anglo-American	100	65¾–66¼
10	Black Sea	All	3–4
10	Brazilian Submarine	All	6¾–7¼
10	Cuba	All	8–8½
10	Ditto, 10 per cent Preference ..	All	13½–14½
10	Direct Spanish	9	5½–6
10	Ditto, 10 per cent Preference ..	All	12–13
20	Direct United States Cable	All	9–9½
10	Eastern	All	7¾–8
..	Ditto, 6 per cent Debenture	..	105–108
10	Ditto, Exten. Australia and China	All	7½–8½
10	German Union Telegraph and Trust	All	8–8½
10	Globe Telegraph and Trust	All	6¼–6½
10	Ditto, 6 per cent Preference	All	10–10½
10	Great Northern	All	8½–9½
25	Indo-European	All	20–22
10	Mediterranean Extension	All	2½–3
10	Ditto, 8 per cent Preference	All	9½–10½
10	Panama and South Pacific	2½	..–..
8	Reuter's	All	10½–10¾
Stock	Submarine	100	195–205
1	Ditto, Scrip	All	1¾–2
10	West India and Panama	All	2½–3
10	Ditto, 10 per cent Preference ..	All	11–12
20	Western and Brazilian	All	11½–12½
1000 dls.	Western Un. U.S. 7 per cent 1st M.B.	All	106–108
100	Ditto, 6 per cent	All	90–92
10	Hooper's Telegraph Works	All	4–4½
50	India-Rubber and Gutta-Percha ..	All	[illegible]
Cert.	Submarine Cables Trust	100	96–100
12	Telegraph Construction	All	23–24
100	Ditto 7 per cent Bonds	All	..–..

PATENTS.

APPLICATIONS FOR LETTERS PATENT.

3416. John Henry Johnson, of 47, Lincoln's Inn Fields, Middlesex, for an invention of "Improvements in electro-magnetic engines."—A communication to him from abroad by José Santiago Camacho, of Paris, in the republic of France.—Dated October 1, 1875.

3431. John Allen Morton, electric bell hanger, of Newcastle-upon-Tyne, for an invention of "A new or mproved self-adjusting electric-bell indicator."—Dated October 2, 1875.

3466. William Prosser, gentleman, of St. Luke, Chelsea, Middlesex, for an invention of "Improvements in lamps adapted to the electric light and in the manipulation of the means employed for the supply of the electric fluid thereto."—Dated October 6, 1875.

NOTICES TO PROCEED.

2946. Camille Alphonse Faure, of Trafalgar Square, Charing Cross, Westminster, has given notice in respect of the invention of "Improvements in thermo-electric batteries and electro-motors."

3364. William Robert Lake, of the firm of Haseltine, Lake, and Co., Patent Agents, Southampton Buildings, London, has given notice in respect of the invention of "Improvements in magneto-electric machines."—A communication to him from abroad by Jim Billing Fuller, of Brooklyn, New York, and John Newland Crandall, of

Norwich, Connecticut, both in the United States of America.

PATENTS

On which the Stamp Duty of £50 has been paid, and dates of their Production for Certificate.

2923. Carl Heinrich Siemens, of 3, Great George Street, Westminster, Middlesex, civil engineer, for an invention of "Improvements in electrical step-by-step instruments and apparatus for giving and receiving telegraphic messages, and for communicating signals and controlling point and signal apparatus on railways, also partly applicable to other signalling purposes."—Partly a communication to him from abroad by Dr. Werner Siemens, of Berlin, in the empire of Germany.—Dated October 3, 1872.

PATENTS GRANTED IN BRITISH COLONIES AND DEPENDENCIES,

Victoria.

Applications for Patents which have been allowed to lapse.

2005. Robert Russel, architect, of 5, Park Hill Terrace, Hoddle Street, Melbourne, Victoria, for an invention of "Improvements in telegraphy."—Dated December 24, 1874. "The object of the invention is to send such information by telegram as will enable the operator at the receiving station to produce a copy of a signature, drawing, &c. To effect this, a piece of transparent paper, properly divided into numbered squares, is placed on the drawing, &c., and the position of the various lines, shades, &c., with respect to the several squares, is telegraphed to the receiving operator."

GRANTS OF PROVISIONAL PROTECTION FOR SIX MONTHS.

3187. Joseph Rogers, electrician, of Owen's Row, Goswell Road, Middlesex, for an invention of "A new or improved galvanic shield or protector for imparting electricity to the chest and lungs and other parts of the human body."

3243. Edwin Powley Alexander, consulting engineer and patent agent, of 14, Southampton Buildings, Middlesex, for an invention of "Improvements in magneto-electric machines and in electro-motive engines."—A communication to him from abroad by Emile Bürgin, of Paris, in the republic of France, engineer.

ABSTRACTS OF SPECIFICATIONS.

Improvements in Telegraphy. Robert Coddington, of 88, Piccadilly, Middlesex. (A communication from Merritt Gally, of Rochester, state of New York, United States of North America.) March 27, 1875.—No. 1128. The object of this invention is, first, to produce simple apparatus, easily adjusted, and not necessitating the use of resistance coils, double batteries, or divided currents; secondly, to allow intermediate offices to be transmitting different messages without interrupting a through message passing in an opposite direction; thirdly, to allow messages to lap by or overreach each other without conflict; fourthly, to allow either or both of the messages passing in opposite directions to be dropped at any number of, or at all, the intermediate stations; fifthly, to so construct the manipulator as to make it available either as transmitter, receiver, or repeater; and sixthly, to furnish improved devices for transmitting or receiving instruments without reference to the particular system of circuits, &c.

Improvements in Galvanic Batteries. Alfred Bennett, telegraph engineer, of 60, Lorrimore Road, Surrey. March 31, 1875.—No. 1169. The object of this invention is to produce a cheap, constant, and effective galvanic battery. As a negative a piece of carbon, platinum, gold, silver, nickel, cobalt, tin, steel, or iron or any suitable substance electro-plated or otherwise is used coated with platinum, gold, silver, nickel, or cobalt packed in a cell of porous material, advantageously of earthenware, with pieces of carbon, coke, cinders, or charcoal or a mixture of any of these with peroxide of manganese, also placing near the bottom of the porous cell or diaphragm a small quantity of nitrate of cobalt, pyrogallic acid, pyrogallate of potash, or pyrogallate of soda. As a positive, an electrode of zinc (which may be amalgamated with mercury) immersed in a solution of hydrate or protoxide of potassium or hydrate or protoxide of sodium is used. A small portion of the solution used may also be added to the negative portion of the cell, but it is desirable to allow it to reach these by percolation through the porous diaphragm. When a powerful but intermittent flow of electricity is required, the following combination may be advantageously used. A negative electrode of platinum, gold, silver, nickel, or cobalt, or any suitable substance electro-plated or otherwise coated with platinum, gold, silver, nickel, or cobalt, packed in a porous diaphragm with pieces of carbon, coke, cinders, or charcoal mixed with peroxide of manganese. As a positive, an electrode of zinc (which may be amalgamated with mercury) in a solution of any salt of ammonia, by preference the chloride. A portion of the solution as used may also be added to the negative. According to another part of this invention a negative of nickel is used or of any suitable substance electro-plated or otherwise coated with that metal, immersed in a solution of a salt of nickel as the nitrate or sulphate or of cobalt or any suitable substance electro-plated or otherwise coated with that metal immersed in a solution of a salt of cobalt as the nitrate or sulphate. The positive portion of the cell consists of zinc. As the essential part of the battery is contained in the negative, the solution used with the zinc may be greatly varied without detriment.

PATENTS GRANTED IN FOREIGN STATES.

Belgium.

37,856. E. Bürgin, for an imported invention of "An electro-magnetic engine."—Dated September 13, 1875. (French patent, September 11, 1875.)

37 904. R. R. Harper, for "An electro-telegraphic apparatus for railway traffic."—Dated September 21, 1875.

United States.

166,712. *Telegraph Transmitters.* H. Middleton, Charleston, S.C. Filed June 10, 1875.—1. The finger springs a^2, in combination with the finger keys K and K' and insulated cores a^1, substantially as and for the purpose described. 2. The finger keys K and K', having springs g applied thereto, as shown, in combination with the metallic letters V^4, substantially as and for the purpose described. 3. The bar Q, with its supports T and T' and adjusting screws x, in combination with the metallic letters V^4, substantially as and for the purpose described.

166,859. *Chemical Telegraphy.* Thomas A Edison, Newark, N. J., assignor to himself and George Harrington, Washington, D.C. Filed July 25, 1874.—Current passing through moistened paper causes evolution of hydrogen, which, uniting with tellurium of stylus, forms hydrotelluric acid, leaving red mark on paper. 1. The method of recording telegraph or other signals by the electro decomposition upon moistened paper or other material of a stylus tellurium. 2. A paper moistened with hydrates of lime, potash, or the cyanides of potassium, for use with a tellurium stylus, for the purpose set forth.

166,861. *Chemical Telegraphy.* Thomas A. Edison, Newark, N.J., assignor to himself and George Harrington, Washington, D.C. Filed July 25, 1874.—Oxygen evolved at stylus raises protoxide to a sesqui or peroxide, which combines with the sulpho-cyanide of potassium, to form red sulpho-cyanide of iron. The combination of a proto-salt of iron, sulpho-cyanide of potassium, and a non-oxidisable stylus, for the purposes set forth.

166,876. *Compound Telegraph Keys.* Marcus L. M. Hussey, Menlo Park, assignor of one-half his right to George W. Barker and William Ettinger, Jersey City, N.J. Filed August 5, 1875.—In base of key is formed a switch-board, so that by revolving the key it may be thrown into any desired one of the circuits connected thereto. 1. The combination, with a single key, of one or more anvils, each representing a different wire or circuit, and all so arranged that the movement of said key or its support serves to bring said key into suitable connection with any desired one of said wires or circuits, substantially as described. 2. The combination of a single key lever, contact point, and anvils, as described; with a connector and local contact, so arranged that upon the movement of said key to connect with any one of the line circuits the local battery and proper sounder connections are simultaneously made, substantially as and for the purposes set forth. 3. The combination, with the main or operative lever, of an auxiliary or spring lever, adapted to hold the main circuit closed when such circuit is not in use, whereby but a single contact point is needed, substantially as and for the purposes set forth. 4. The combination of two discs or plates, one provided with a single key lever and the other provided with one or more contact points, through which various telegraphic circuits pass, one plate being movable in relation to the other, whereby the movement of one plate upon the other brings the key lever into position to operate any desired circuit of the series, substantially as set forth. 5. The combination of the key, the table C, and spring O with posts M, circle connector M′, and post N, substantially as and for the purposes set forth. 6. The combination of the key A and latch spring A′*a* with the circuit-plate G, posts K and I *i*, substantially as and for the purposes set forth.

166,877. *Electric Lights.* Steven Alexandrovitch Kosloff, Paris, France. Filed June 23, 1875.—1. The carbon electrodes provided with insulated supports independent of the metallic conductor, substantially as herein described. 2. The combination of the carbon pins *f*, having the enlarged ends *d*, with the metal conductors *e*, inserted into the said enlarged ends of the carbons, substantially as shown and described, for the object specified. 3. The combination of the carbon pins *f*, having the enlarged ends *d*, the wires *e*, and the links *o*, flexibly connecting the said wires and the principal conductors, as herein shown and described. 4. The supporting column *h*, arranged within and filling a portion of the globe or cover *k*, substantially as and for the purpose herein specified.

166,911. *Printing Telegraphs.* Alois Wirsching, Brooklyn, E.D., N.Y. Filed April 29, 1875.—Circuit to printing magnet is through a metallic pin upon escapement wheel, and a metallic pin attached to insulated collar upon type wheel shaft, the two being brought together by the stopping of the escapement wheel. When the wheel begins to revolve the pin upon it is carried forward by the stress of the coiled spring against a non-conducting pin projecting from the insulated collar. In combination with the escapement wheel, mounted loosely on the type wheel shaft of a printing telegraph, and connected to the same by a spiral spring, and with the armature of the line magnet, the pins *g h i*, insulated metallic collar *j*, spring *m*, and printing magnet C, substantially as and for the purpose set forth.

167,162. *Electro-therapeutic Appliances.* Elizabeth J. French, Philadelphia, Pa. Filed July 9, 1875.—Claim.—" 1. The galvanic element consisting of the triple strip A_1, formed of strips of zinc, copper, and brass, substantially as and for the purpose set forth. 2. The triple strip A_1, consisting of strips of zinc, copper, and brass, combined at one end, and formed into the shape of a horse-shoe magnet at the other end, substantially as and for the purpose set forth. 3. The triple strip A_1, in combination with the eye E, substantially as and for the purpose set forth. 4. The triple strip A_1, consisting of strips of zinc, copper, and brass, one of the strips being formed with the laps or folds *a*, holding or securing together all the strips, substantially as and for the purpose set forth."

167,173. *Galvanic Batteries.* Edward A. Hill, Chicago, Ill. Filed July 20, 1875.—Brief.—" Prevents the flow of the sulphate of copper to the zinc by means of a tube and plate of lead suspended above the sulphate of copper. While furnishing a plate upon which the copper will be deposited if the sulphate of copper solution rises too high, the tube and plate present also a convenient means for the introduction of the fresh sulphate of copper." Claim.—" 1. The device B, constructed of lead or other incorrodible metal, when supported above the bottom of the containing cell, substantially as and for the purpose herein specified. 2. The combination of the device B with the copper or — plate, having supports fixed or resting thereon, substantially as and for the purpose specified."

167,242. *Automatic Telegraph Apparatus.* Otto Heikel, Jersey city, N.J. Filed June 5, 1875.—Claim.—" 1. The rollers 3 3, upon the wires 2 2, and within the grooved wheel or bar, in combination with the cord *d*, and circuit-closing mechanism, substantially as set forth. 2. The swinging circuit-changer or needle *o*, within the helix *p*, and the permanent magnets *r* and *s*, arranged as set forth, in combination with the bar *x*, that connects the said magnets *r s*, and the helix *w*, surrounding such bar, as set forth. 3. The polarised lever *l*, and ink-roller l^1, operated by the magnets n, n^1, and electric circuits, in combination with the blade *m*, and rollers m^2, for moving a strip of paper in contact with such blade and contiguous to the ink-roller, for the purposes set forth. 4. The combination, in a telegraph transmitting instrument, of movable circuit-closing rollers or blocks, a key, a magneto-electric machine, and gearing connecting the parts, substantially as specified, for transmitting reverse currents alternately and at intervals, to form the message, as set forth."

Re-issues.

6599. *Electro-magnetic House Alarms.* William G. Russell and Abraham Firth, Boston, Mass., executors of William Whiting, deceased, assignors to Edwin T. Holmes. Patent No. 20,970, dated July 20, 1858; extended seven years. Filed July 23, 1875.—1. The improved house alarm, substantially as hereinbefore described, consisting of the combination of the following elements, viz.: First, a series of electro-magnetic circuits; second, an indicator to designate the respective circuits; third, an alarm apparatus common to all the circuits of the series; fourth, the window or door springs—the whole operating, as set forth, to put in operation the alarm apparatus that is common to all the circuits of the series, and to indicate the particular circuit of the series which is attacked. 2. The combination, substantially as before set forth, of the following devices, viz.: the series of magnetic circuits, the alarm apparatus common to all the circuits of the series, and the switch for disconnecting a particular circuit of the series of circuits from the alarm apparatus without disconnecting the remainder of the series of circuits from the apparatus.

6623. Dexter W. Parker, Meriden, Conn., assignor to Chas. Parker, of the same place, for " Claw-hammers." Patent No. 147,427, dated February 10, 1874. Filed September 30, 1874.—Claim.—" The herein-described hammer, constructed by placing in the mould the previously-prepared head, then pouring the metal for the body into the mould, substantially as described."

TO CORRESPONDENTS.

*** Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which "The Electrical News and Telegraphic Reporter" is the organ, will always command attention. Literary communications and books for review should be addressed to the Editor; business communications to the Publisher, Boy Court, Ludgate Hill, London, E.C.

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October 14, 1875.

THE

ELECTRICAL NEWS

AND

Edited by Wm. Crookes, F.R.S., &c.] TELEGRAPHIC REPORTER. [*Registered for Transmission Abroad.*

Vol. 1.—No. 17.] November 1, 1875. [PRICE, 3d. POST FREE, 3½d.

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NOTICE.

THE

ELECTRICAL NEWS

AND

TELEGRAPHIC REPORTER,

Edited by WILLIAM CROOKES, F.R.S., &c.,

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BOY COURT, LUDGATE HILL, LONDON, E.C.

THE ELECTRICAL NEWS.

Vol. I. No. 17.

SIR CHARLES WHEATSTONE.

Few lives illustrate more forcibly the benefit Science confers upon mankind than that of the great physicist whose death last week was more than a national loss. The name of Wheatstone was a household word in every corner of the civilised world. For it was a name which in the *popular estimate* was that of the highest type of philosopher, as being "a practical man" who really put his knowledge to some use. But whilst the common public can only understand Science from the side of bread and cheese, happily for himself Wheatstone's fame rests upon more enduring ground than this. Let us briefly sum up the events of his memorable life.

Born at Gloucester in 1802, Charles Wheatstone was a tradesman's son, and was himself for some years a maker and seller of musical instruments in London. A youth of remarkable mechanical ingenuity, and with a fair knowledge of mathematics, his mind—like that of Faraday —soon expanded beyond the narrow limits of trade. In 1823 he made his first contribution to Science in a paper published in Thomson's *Annals of Philosophy*, entitled "New Experiments on Sound." His next papers, also on Sound, appeared in the *Quarterly Journal of Science* for 1827 and 1828. Here it was that pretty instrument the kaleidophone was described, consisting, as many know, of a silvered bead fastened to the free end of a vibrating knitting-needle, the other extremity of which was held in a vice. The lovely curves traced out by the persistence of the impression of the moving bead makes the instrument a simple and beautiful toy; but it soon became more than a toy, when, by using thin rectangular rods instead of a knitting-needle, a beautiful optical representation was obtained of the musical intervals. Subsequently, by a most ingenious mechanism, Wheatstone succeeded in producing any desired combination of rectangular vibrations. The principle of the kaleidophone was afterwards also employed by Wheatstone as a photometer. A silvered bead was made to rotate rapidly, and the illuminating power was estimated by a comparison of the reflected circles of light from the two sources—a method peculiarly applicable to estimating the brilliancy of lighthouses. Thus the study of Sound led Wheatstone to Light, and upon these two subjects were all his earlier papers, up indeed till the year 1840—if we except his famous determination of the velocity of electricity and the duration of the electric spark, made in the year 1834.

Wheatstone's principal contribution to Acoustics is a memoir on the so-called "Chladni's figures"—the figures obtained by strewing sand on vibrating surfaces. This paper was, through Prof. Faraday, presented to the Royal Society in 1833, and is published in the *Transactions* of that year. It is a masterly and important investigation, containing the first analysis of the beautiful but complex figures revealed by Chladni. In this paper Wheatstone shows that the most intricate of these sand figures can be expressed analytically by considering the plate as the seat of two rectangular systems of superposed vibrations,—the resultant motion being the sum of the concurring or the difference of the opposing vibrations. The figures thus obtained may be either a perfect resultant, where similar modes of vibration are superposed exactly equal in intensity, or an imperfect resultant, where the intensity is unequal. Notwithstanding the multitude and complexity of figures thus obtainable it appears, and we quote from his memoir, "that every figure of a square surface which experiment can give may be reduced to a primary figure with parallel lines giving the same sound." This result is similar to that established for fluids in 1825 by the brothers Weber, in their famous researches on waves, and of which Wheatstone was ignorant when he wrote.

In the next year, 1834, Wheatstone was appointed to the chair of Experimental Physics in King's College, London. We believe he did not take any very regular part in the College course of lectures, but the reputation he conferred upon the College, and the aid he gave to his colleagues by his knowledge and advice, was of great value. Nevertheless he frequently gave short courses of lectures at King's College. Before us, for instance, is the detailed syllabus of a course of eight lectures on Sound, delivered by Wheatstone at King's College, in the early part of 1835. It would have been a gain to general knowledge had these lectures been preserved, for the outline of them is full of interest. It was owing to the difficulty Wheatstone experienced in public lecturing that Faraday so often gave an account of Wheatstone's discoveries on those delightful Friday evening meetings at the Royal Institution. Thus in 1829 we find Faraday lecturing on Wheatstone's experiments on the vibration of columns of air: in 1840 he writes to his friend to let him have the telegraph subject this season, for "you know," Faraday remarks, "my desire to present your beautiful developments to our audience." In 1846 and in 1858 we find Faraday again lecturing upon Wheatstone's fertile applications of Science.

In a paper read before the Dublin meeting of the British Association, in 1835, Wheatstone announced the existence of rays, of definite refrangibility, emitted on the volatilisation of metals by the electric spark. Fraünhofer had already discovered that the spectrum of an ordinary electric spark is crossed by bright lines, but he had not gone further than this. Wheatstone shows, in the paper to which we have referred, that the "bright lines differ in number and position in every different metal employed, . . . the appearances being so different that by this mode of examination the metals may be readily distinguished from each other:" a table, indeed, accompanied the paper, showing the position and colour of the lines in the spectra of the various metals used. Sir J. Herschel and Mr. Fox Talbot had previously announced the discovery of bright lines in the spectra of flames, but Wheatstone seems to have given the first clear intimation of modern spectrum analysis.

In the 1838 meeting of the British Association Wheatstone gave a summary of a paper on "Binocular Vision" that appears at length in the *Transactions of the Royal Society*. At the meeting he exhibited an apparatus which he proposed "to call a Stereoscope, from its property of presenting to the mind the perfect resemblances of solid objects." As is well known, this is the original form of the stereoscope, and consisted essentially of two plane mirrors inclined at an angle of 90°. Sir David Brewster's lenticular stereoscope undoubtedly made the instrument more useful and more widely known, but was not published till 1849, and also at a subsequent British Association meeting.

At a meeting of the same Association in 1848 Wheatstone described an instrument for ascertaining the hour of the day by observing the amount of polarisation of the light of the sky. This instrument—which consists essentially of a double-image prism and a thin plate of selenite enclosed in a tube pointing in the direction of the earth's axis—is founded on the law discovered by Brewster, that the plane of polarisation of the sky is always 90° from the sun. Hence when the prism (which carries an index finger traversing a semicircle on which the hours are engraved) is rotated till no colour is perceived, the index will point to the right time. Unlike Wheatstone's other practical applications of Science, the "polar clock," as it is termed, has not come into use; it was hardly to be expected it would, but as a simple and interesting piece of apparatus we wonder it has not found its way into many drawing-rooms, where, like the stereoscope and the polariscope, it might pleasantly occupy leisure minutes.

The immense value of Wheatstone's electrical inventions has to some extent hidden the importance of his papers on Sound and Light. Moreover, his contributions are so scattered in different scientific publications that they are often lost sight of, and it would therefore be a great advantage if his executors were to cause his valuable papers to be collected and published in an accessible form.

We must now turn to Wheatstone's connection with the introduction of and the improvements in the Electric Telegraph. Concerning the latter no one has doubted that it was his mechanical genius which really surmounted all the obstacles that threatened to hinder the usefulness of this magnificent application of Science. In reference to the oft-disputed question whether Wheatstone first introduced Telegraphy, there is an important paper bearing on this point in the *Magazine of Popular Science* for 1837. This paper corroborates what is now generally known. The writer—dating from Munich, December 23, 1836—states that Prof. Steinheil communicated to a recent meeting of the Munich Academy of Sciences a letter from Prof. Gauss, wherein is stated the fact that signals are regularly sent between his laboratory and the observatory, by means of voltaic electricity. Prof. Steinheil explained that these signals were for the purpose of recording the absolute magnetic variation, and exhibited the apparatus at the meeting: it consisted of a heavy magnetic bar suspended within a coil of fine wire. Prof. Steinheil further added that Gauss had proposed to apply this to telegraphic communication, using apparently the isochronous vibration of a similar bar at the distant extremity. Signals were indeed sent from the room to a distant apartment, and answers received, Prof. Steinheil hoping that by this demonstration people would be induced to try it on much greater distances. To this paper the Editor of the Magazine appends the following important foot-note:—

"During the month of June last year, 1836, in a course of lectures delivered at King's College, London, Professor Wheatstone repeated his experiments on the velocity of electricity, which were published in the *Philosophical Transactions* for 1834, but with an insulated circuit of copper-wire, the length of which was now increased to nearly 4 miles: the thickness of the wire was $\frac{1}{15}$th of an inch. . . But, which has a more direct reference to the subject of our esteemed correspondent's communication from Munich, Prof. Wheatstone gave a sketch of the means by which he proposes to convert his apparatus into an electrical telegraph, which, by the aid of a few finger-stops, will instantaneously and distinctly convey communications between the most distant points. These experiments are, we understand, still in progress, and the apparatus, as it is at present constructed, is capable of conveying thirty simple signals, which, combined in various manners, will be fully sufficient for the purposes of telegraphic communication."—*Magazine of Popular Science*, vol. iii., p. 110.

De la Rive, in his "Treatise on Electricity," takes the same view of the case. He writes:—

"The philosopher who was the first to contribute by his labours, as ingenious as they were persevering, is

giving to electric telegraphy the practical character that it now possesses, is, without any doubt, Mr. Wheatstone. This illustrious philosopher was led to this beautiful result by the researches that he had made in 1834, upon the velocity of electricity,—researches in which he had employed insulated wires of several miles in length, and which had demonstrated to him the possibility of making voltaic and magneto-electric currents to pass through circuits of this length. It was in 1837, in the month of June, that Mr. Wheatstone took out his first patent. He first employed five conducting wires, between two distant stations, acting upon five magnetised needles, the movements of which, being combined two and two, were enabled to produce several different signs. Mr. Wheatstone, at this time, entered into partnership with Mr. Cooke, who had likewise devised an ingenious telegraphic apparatus founded upon the same principles. The English philosophers, from the very first, had added to the telegraph—properly so called—an apparatus intended to call the attention of the observers, and designated under the name of *Alarum*. . . . The principle upon which this alarum is founded includes an immense number of applications, for it enables man to put in action—at any distance whatever—all the forces of mechanics, in an instantaneous manner. Indeed, more recently, Mr. Wheatstone applied it to the construction of his dial telegraph; and it is the same principle which serves as the basis of Morse's telegraph, invented at nearly the same period."—*De la Rive*, Part vii., Chap. I.

Although it is thus made clear, and is in fact generally acknowledged, that Wheatstone was the first to bring the electric telegraph to a practical issue, yet it must not be forgotten that other names prior to Wheatstone undoubtedly gave birth to the idea of communication by telegraph. The name of Ronalds and of Morse will at once occur to every well-informed reader. The relative claims of these men is fairly expressed in the following extract from a letter recently addressed to the *Daily News*:—

"In the spring of 1869 a great public banquet in New York, at which the British Minister, Mr. Thornton, was present, was given to Professor Morse, who, in his speech on that occasion, maintained a claim of priority for America against England on the ground of the invention of the telegraph by himself in 1832,—which date he contrasted with that of 1837, when Messrs. Cooke and Wheatstone took out their first English patent for an electric telegraph. It is probably a fact that Wheatstone knew nothing of Morse's theories and experiments, when he was striving to obtain the attention of the scientific world to his own; but in a controversy which turns upon dates I would call attention to the fact that, so far back as 1823, a pamphlet was published in this country under the title of "Description of an Electric Telegraph, and of some other Electrical Apparatus, by Francis Ronalds," 'printed for R. Hunter, 72, St. Paul's Churchyard, 1823.' In this work Mr. Ronalds fully describes his invention, with illustrative diagrams, and foretells, in a striking manner, some of the public uses to which it might be applied. 'Why,' he says, 'should not our kings hold councils at Brighton with their ministers in London?' 'Why should our defaulters escape by default of our foggy climate?' 'Let us have electrical *conversazione* offices, communicating with each other all over the kingdom, if we can.' 'Give me *material* enough, and I will electrify the world.' The telegraph so described in 1823 had been, in fact, constructed by Mr. Ronalds so far back as 1816, in which year he offered it to the then Government, receiving an official reply that 'Telegraphs of any kind are now wholly unnecessary, and no other than the one now in use will be adopted.'—Dated 'Admiralty Office, 1816.' The original letter, written by Mr. (afterwards Sir John) Barrow, Secretary to the Admiralty, is in my possession. In 1870 Mr. Ronalds received the honour of knighthood for his 'early and remarkable labours in telegraphic investigations.'"

The great difference between Ronalds's telegraph and Wheatstone's consists in the fact that the former employed electricity of high tension obtained by friction, and the latter employed voltaic electricity. It is this difference which constitutes success or failure. Ronalds's telegraph could never have come into practical employment, as any one may judge who looks at his apparatus now preserved at the Kew Observatory. Wheatstone's telegraph, on the other hand, came into rapid use everywhere.

According to De la Rive, to Wheatstone is also due the first idea that telegraphic lines might be carried across the sea, and in 1840 he had combined all the means necessary for the execution of a submarine telegraph, although the first submarine message was not sent till 1849: the Dover and Calais—the first permanent—cable was laid in 1851.*

Wheatstone's fertility of invention seemed endless. Innumerable forms of telegraphic instruments he successively brought out. To describe each of these would be to write a treatise on telegraphy. The mode of transforming the alternating motion of an armature into the intermittent circular motion of an index to a dial is peculiarly Wheatstone's, and soon became a prolific source of new instruments. The beautiful A B C telegraph and its ingenious mechanism was subsequently devised by Froment, and soon applied by Wheatstone with exquisite skill to the feeble alternate magneto-electric current discovered by Faraday. Perhaps no improvement has been so valuable in accelerating the speed of messages as his automatic system. Here the messages are first punched on paper ribbons, and are transmitted, by a modification of a Morse instrument, at as fast a rate as the paper can pass between the rollers of the transmitting instrument. In this manner messages are constantly sent at the rate of 120 words a minute, or as fast as they can be uttered by the most rapid speaker. This of course means after the words have been punched: moreover, the tape thus prepared can be run through a dozen instruments in succession; hence accuracy, as well as speed, is secured.

But Wheatstone did not confine his electrical improvements to telegraphy alone. Simultaneously with Bain and Steinheil he solved the problem of electric clocks, multiplying at pleasure the indications of one clock. Wheatstone's system of electric clocks, especially his

* Those who are interested in the question of the introduction of submarine telegraphy should read the report of a valuable and interesting lecture by Mr. Brett, published in the *Proceedings of the Royal Institution* for March 20, 1857.

magneto-electric clocks, have largely come into use; they may be seen always at work at Burlington House, at the Royal Institution, and in many private houses.

Electric registers was another of Wheatstone's inventions. He devised an apparatus capable of being raised into the atmosphere by a captive balloon, and recording, every six minutes, at different heights, the temperature and pressure of the air, the moisture, the direction and force of the wind, &c. The same method would enable anyone to determine at each instant the temperature and volume of the water even in the deepest Artesian well. By another instrument he applied magneto-electricity to record the number of visitors entering a building through a door; and not only was the number of times the door opened and closed registered, but also the time the door took in opening, and the fact whether the door remains permanently open or not. Applied to record the number of copies struck from a printing-press, this instrument is in frequent use; at the *Times* office, for example, several of these automatic registers are employed. Nor must we forget, in connection with these applications of Electricity, the fact that Wheatstone was the first to employ an electric current as a chronoscope. By this means he was able to register the velocity of a bullet; a wire being broken, and thus the circuit interrupted, by the bullet the moment it emerges from the gun, and the current re-established by its striking a target. This is essentially the same system that is in constant use to-day at the trials of the energy of projectiles.

So far we have considered Wheatstone's wonderful fertility of resource in the mechanical development of the electric telegraph. We must now go back to an earlier period of his life, and notice briefly some of his contributions to the less practical aspects of electricity. First in order comes his determination of the velocity of electricity, made in 1834, and which had such pregnant consequences, as we have already seen. Wheatstone, it is true, was not the first to prove that electricity travelled at an enormous speed. In 1748 Watson had joined the inner and outer coatings of a Leyden jar by an iron wire, 12,276 feet long, sustained in the air by insulating supports: the observer failed to perceive any sensible interval elapse, through the time taken by the discharge traversing this great length of wire. Wheatstone, however, approached the subject in a far more refined and exact manner. By means of his invention of the revolving mirror—which has since come into frequent use in the determination of small intervals—he contrived to measure the velocity of this discharge from a Leyden jar, and showed that the electricity must have traversed the wire he employed at the rate of 288,000 miles per second. His experiments, moreover, showed that the electric discharge takes place simultaneously from the inner and outer coating of the jar, and arrives latest at the middle of the circuit.

It must not be inferred, however, that the velocity of electricity through telegraph wires, much less in submarine cables, is equal to this prodigious speed. Much to the surprise of electricians, when experiments in this direction were made, the velocity of electricity was found to vary from 100,000 miles a second down even to 3000 miles a second. The cause of these enormous differences was pointed out by Faraday, who showed that a retardation of the current took place, caused by the inductive action of surrounding conductors; that thus, in fact, the wire became transformed into the inner coating of a Leyden jar. This is notably the case in submarine cables, where the insulating sheath and the ocean around play the part of the glass and the outer tin-foil coating of the Leyden jar. Hence, from this inductive embarrassment, the current is held within the cable, and the rate at which signals will pass depends therefore upon other considerations beside those of the mere velocity of the electric wave. Indeed, the arrival of a signal through a submarine cable is—as all electricians know well—very like the incoming of some subtle tidal wave. Almost instantaneously an insensible thrill is transmitted to the far end of the wire, but this thrill is too feeble to affect the instrument, and time must elapse till fresh accessions of power will enable the current to perform the mechanical motion of moving the needle of the receiving instruments. Hence greater delicacy in the receiving instruments should cause a greater rate of signalling, and this is actually the case. To Wheatstone is due no small share in showing the cause of this retardation of submarine signals. Along with Faraday he established the fact that the propagation of electricity is made, as it were, by a series of waves analogous to those by which sound is transmitted.

We must now refer to the immense service Wheatstone rendered electrical science by the means he discovered for the exact measurement of the resistance in a circuit. It was through Faraday and Wheatstone mainly that electricity passed from its qualitative to its quantitative stage—a transition which, more than anything else, marks the progress of specialised knowledge. Wheatstone's paper, printed in the *Transactions of the Royal Society* for 1843, and entitled "An Account of several New Instruments and Processes for Determining the Constants of a Voltaic Circuit," contained a description of the rheostat and the famous

"Bridge" which bears his name. The object of the first-named instrument, we need hardly say, is to measure the current strength by the interposition of a wire which produces a known resistance; then, by varying the length of this wire by a definite amount, causing an equality in the galvanometric effect produced by any two currents, which may thus separately be compared, and the relative strength of one to the other thereby estimated. Under various forms this instrument still remains indispensable in the cabinet of the physicist.

But it is by "Wheatstone's bridge" that the subject of our memoir is, perhaps, most widely and gratefully remembered by physicists generally. The object of this instrument is too well known by every electrician to render it needful for us to describe it, further than to say it is essentially a differential instrument depending on the law of derived circuits, which Wheatstone was the first to apply to electrical measurement. Upon the same law he also describes, in the paper to which we have referred, the now universally-used "shunt," and shows how a delicate galvanometer can thus be employed to measure any current strength, giving, too, the necessary formula to be used when the "reducing wire"—as he terms it—is introduced. But our space is more than exhausted, though we have by no means exhausted the benefits Wheatstone has conferred to both pure and applied science.

It only remains for us to notice the personal loss this Journal has sustained by the death of Sir Charles Wheatstone. When the first number of the Electrical News appeared, Sir Charles expressed to its present editor the liveliest interest in its future prosperity, and had, moreover, several communications with us respecting the means for increasing its usefulness and securing its ultimate success. Not only did he promise his invaluable aid, but even in the midst of feeble health he collected a number of hitherto unpublished notes, and it was arranged that a short-hand writer should—by taking down his thoughts—save him the trouble of writing. Unfortunately for ourselves, and we may add for Science also, Death laid its hand upon him ere his kind intentions could be carried out. It is to be hoped that the world will not lose the benefit of his unpublished papers, for we believe it is no secret that he had obtained latterly some new results which he esteemed of great value, and upon which he had promised us an early communication.

As we have regarded Sir Charles Wheatstone only from a scientific standpoint, leaving others to speak of him in his kindly home life, we cannot do better than conclude this hasty and imperfect notice in the words which Faraday uttered, nearly twenty years ago, as the lesson to be drawn from the career of one who did perhaps more than any single individual to increase the material and intellectual prosperity of mankind. Faraday says:—

> "Wheatstone's life is an argument in favour of a large public recognition of scientific education, because in Wheatstone we find a man both of science and practice, and his career is a strong illustration of the effects which a general scientific education may be expected to produce. . . . Such an education teaches us to be *neglectful* of nothing; not to despise the small beginnings, for they precede of necessity all great things in the knowledge of Science, either pure or applied. It teaches a continual comparison of *small and great*, and that under differences almost approaching the infinite; thus the mind becomes comprehensive. It teaches us to deduce *principles* carefully, to hold them firmly, or to suspend the judgment; to discover and obey *law*, and by it to be bold in applying to the greatest what we know of the smallest. It teaches us first, by tuition and books, to learn that which is already known to others, and then by the light and methods of Science to learn for ourselves and for others,—so making a fruitful return to man in the future for that which we have obtained from man in the past."*

Such faithful words cannot be too often pressed upon the attention of the nation.

SIR WILLIAM THOMSON'S REPORT TO MESSRS. SIEMENS BROTHERS

ON TESTS OF

DIRECT UNITED STATES CABLE,

Taken at Ballinskelligs Bay Station, September 16 and 17, 1875.

On Wednesday evening, September 15th, I arrived at Waterville, and proceeded thence to the cable station at Ballinskelligs Bay. There your electrician, Mr. Ebel, met me, and showed me the instruments which he was ready to put at my disposal for the tests; and Mr. Gavey, the Company's superintendent, obligingly lent me a number of additional condensers which I desired for measuring the electrostatic capacity of the line. Having made preliminary arrangements, and learned that, by orders from London, the line was to be at my disposal from 7 till 10 next morning, I returned to Waterville for the night, appointing to meet Mr. Ebel at the station in the morning at 7 o'clock.

About 8 a.m. on the 16th, after some preliminary trials of the instruments in connection with the cable, which showed strong earth-currents, I commenced testing for insulation with a battery of 20 cells, having its two poles constantly joined through a resistance of 20,000 Siemens units, but found so great disturbance by the earth-currents that it was impossible to

* Faraday, Lecture on Wheatstone's Electric Telegraph in relation to Science; Royal Institution, January 11, 1858.

get a result. I first applied the battery for a quarter of an hour, zinc to line, then for seven minutes line to earth, then twenty minutes copper to line, and lastly, thirteen minutes line to earth. During the whole time a galvanometer, in circuit with the cable, showed strong currents alternately in the two directions, and varying from extreme positive to extreme negative with great rapidity. To keep the readings within a convenient range I was obliged to shunt the coil so powerfully as to reduce the deflection to about 1-20th of what it would have been with a degree of sensibility proper for measuring the insulation resistance. The deflection was read off and written down every ten seconds during nearly all the time. A careful examination of these recorded results shows no sensible preponderance of current in the direction due to the battery, whether with copper to line or zinc to line; and no perceptible difference in the currents when the line was put to earth directly instead of through the battery in either direction. The currents observed were frequently ten times, and sometimes more than sixteen times, as strong as what I afterwards found to be the true leakage current, and the extremes were about as often in one direction as the other. The strongest current of all chanced to be in one of the periods when the line was simply to earth without battery. The sums of the readings taken during successive minutes show that the insulation resistance, whether with zinc or copper to line, cannot have been less than a megohm, and that it was probably not less than 2 megohms.

I next measured the electrostatic capacity by the method which I described in a communication to the Society of Telegraph Engineers, published in the *Proceedings* for 1873. I used three boxes of your resistance coils with 20,000 units on one side of the point put to earth, and an adjusted resistance made on a box of 10,000 on the other side. The current from a well-insulated battery of 80 cells was kept flowing through these coils. With the condensers lent by Mr. Gavey. in addition to your own, I had 80 microfarads in all. By means of the battery and resistance coils, arranged in the manner described, the cable and condensers were charged oppositely in measured proportions, then connected together, kept so for about ten seconds,* and then discharged through the galvanometer to earth. Mr. Ebel's insulation galvanometer with its ordinary magnetic adjustment was used, but its coil was strongly shunted to avoid over sensibility. Thus, after repeated trials, I found that when the cable and condensers were charged to opposite potentials in the proportion of 1600 to 20,000, and then put in connection with one another, the charge in the cable was overborne by that in the condensers; but with the proportion 1630 to 20,000 the charge in the cable preponderated. Hence, about 1615 to 20,000 would have given zero; and, therefore the capacity of the cable was—

$$\frac{20,000}{1615} \times 80 \text{ microfarads,}$$

that is, 991 microfarads (or 0·409 of a microfarad per knot, the length of the cable being 2420 knots).

I could have come much more closely to the exact proportion of the charges required to give the zero had the cable been at my disposal for half-an-hour longer, or had I perceived in time that one of the commutators which Mr. Ebel had left at my disposal could, in a few minutes, have been arranged to make the requisite connections by a simple manipulation instead of a somewhat cumbrous arrangement which I had extemporised. The quickness of this process, even with the cumbrous arrangement which I used, is such that it is much less disturbed by earth-currents than the ordinary tests for insulation or copper resistance. It is, in fact, disturbed only by whatever change there may be in the terrestrial potential along the line of the cable during the ten (or five) seconds between the insulated wire of the cable and the battery, and discharging the connected wire and condenser to earth through the galvanometer.

The last quarter-hour of the time for which the cable was at my disposal was spent in a somewhat hurried measurement of the copper-resistance. The line was found to be still greatly disturbed by earth-currents. A battery of 20 cells was applied during twelve minutes, first zinc to line and copper applied to earth, and then suddenly reversed, and kept so till 10 o'clock (the time arranged for the conclusion of my tests), when signalling from the remote end commenced. During the whole twelve minutes there was a difference of potential between the Irish and Nova-Scotian earths, varying rapidly in amount from a least minimum of 5 cells to a greatest maximum of 18 cells, but always in the same direction—the Irish earth positive relatively to the Nova-Scotian earth. The ordinary bridge method could have given no result at all in so disturbed a condition of the line; but the simple method of deflection (the only proper method for measuring copper-resistance in a submerged cable), in which is observed the difference of the readings immediately before and quickly after reversal of the battery, gave an approximate result, which in round numbers I took as 7300 Siemens units.

The cable being offered to me again from midnight till 2 a.m. on the 17th, I made another series of tests at that time, for the main object of measuring the insulation-resistance. I found the line in a much less disturbed state, and was

* Five seconds would have been quite long enough.

able to make a perfectly satisfactory insulation test by the ordinary galvanometer method. I applied, however, also a new method which (no electrometer being available) I had planned to meet the contingency of the line being disturbed by earth-currents so much as to render the ordinary test unsatisfactory, but not so much as to vitiate an electrometer-test. This method, which I think may be found generally useful for testing submerged cables when an electrometer is not available, is as follows :—

1. Apply the ordinary test by battery and galvanometer for a certain time.

2. Insulate the cable for a certain time and then shunt the galvanometer to prepare for No. 3 (unless you have convenieatly available a second galvanometer suitable for discharges).

3. Instantaneously re-apply the battery, through the insulation galvanometer properly shunted (or a special discharge galvanometer), to the cable, and observe the maximum of the sudden deflection produced.

4. Go on repeating Nos. 1, 2, and 3 as long as you think proper, according to circumstances.

5. To determine the proper ballistic constant of the galvanometer for utilising the observed result of No. 3, find the maximum of the sudden deflection which takes place when a sudden change of electrification is produced by instantaneously changing by a small measured difference the potential of one electrode of the galvanometer, the other electrode being in connection with the cable.

6. The change of potential which, in the operation of No. 5, would give the same deflection as that observed in No. 3, is equal to the change of potential which the conductor of the cable has experienced during the time when it was left insulated according to No. 2. Hence calculate the insulation-resistance in ohms or megohms as in the ordinary electrometer method, when the electrostatic capacity of the table is known.

At 12 h. 2 m. on the morning of the 17th, the 20-cell insulation battery (with its poles again, as on previous occasions, joined through 20,000 Siemens units) was applied, zinc to cable, through the insulation galvanometer with a shunt of 5000 Siemens units on it. Then, commencing at 12 h. 2 m, 50 s., the galvanometer indication was read and recorded every ten seconds till 12 h. 6 m., when the cable was insulated during a minute, according to No. 2 of the directions above, and a shunt of 30 substituted for the 5000. At 12 h. 7 m. the battery was instantaneously re-applied, the throw of the galvanometer observed according to No. 3, and the shunt of 30 removed and 5000 re-applied. The battery was kept on till 12 h. 8 m., when the cable was again insulated for a minute, the galvanometer shunted with 50 (instead of the 30 used the first time), and the operation of No. 3 repeated. This process of re-applying the battery and re-insulating the cable, in alternate minutes, was continued till 12 h. 26 m. Then an interval of five minutes was spent in determining, according to No. 5, the proper ballistic constant of the galvanometer, by applying alternately full power and $\frac{39}{40}$ of full power of the insulation battery; the change from one power to the other being made in each case as instantaneously as possible. Lastly, the shunt of 5000 was re-applied at 12 h. 31 m. for insulation-test, and one more period of the alternating process performed from 12 h. 32 m. to 12 h. 34 m., when the cable was put to earth to prepare for insulation-test with copper to line. Either three or four, generally four, galvanometer readings for ordinary insulation-test were taken at intervals of ten seconds in the second half of each minute during which the battery was applied. Twelve galvanometer readings, taken at ten seconds intervals during the second and third minutes of the electrification, gave for mean deflection 127, and the readings taken during the second halves of the fourth, eighth, tenth, twelfth, fourteenth, sixteenth, eighteenth, twentieth, twenty-second, and twenty-fourth minutes gave for mean deflection 82·1. The sensibility of the galvanometer in the condition in which it was used for these readings was such that a deflection of 290 would have been given by the actual battery, with a resistance of 10^6 Siemens units. Hence, the insulation-resistances proved by the mean observed deflections were as follows :—

Mean Deflection.		Insulation Resistance.	
127·0	(2nd and 3rd mins.)	$2·28 \times 10^6$	Siemens units.
82·1	(4th, 6th, . . 24th)	$3·54 \times 10^6$	

The new method described above gave the following ballistic deflections or "throws":—

End of 5th minute	...	70 divisions.
" 7th "	...	102 "
" 9th "	...	102 "
" 11th "	...	109 "
" 13th "	...	57 "
" 15th "	...	52 "
" 17th "	...	92 "
" 19th "	...	102 "
" 21st "	...	110 "
" 23rd "	...	102 "
Mean ...	...	89·8
Say ...	...	90·0

The ballistic deflection due to instantaneously changing the potential by 1-40th of that of the insulation battery, in accordance with the rule of No. 5 above, was found to be 112 divisions. This is $1\frac{1}{4}$ time the preceding mean throw, which therefore showed a change of potential

equal to 1-50th of that of the battery. Hence the mean of the falls of potential in the ten alternate minutes during which the line was insulated was 1-50th of the potential at the beginning of each of them, or (nearly enough) 1-50th of the mean potential during the minute. Therefore, the loss was at the rate of 1-50th per minute, or 1-3000th per second. Now, I had found the electrostatic capacity of the cable to be 991 microfarads. Hence the insulation-resistance proved by this mean result is $\frac{3000}{991}$, or 3·027 megohms, or—

3,170,000 Siemens units.

This agrees quite as nearly as could be expected with the

3,540,000 Siemens units

deduced from the means of the galvanometer deflections during the alternate minutes when the battery was in action, as described above.

(To be continued.)

ON THE TELEGRAPHIC PROBLEMS OF DOUBLE SENDING AND QUADRUPLEX TELEGRAPHY.*

By G. K. WINTER.

The practical success which has attended the revival of duplex telegraphy has doubtless led many besides myself to inquire whether the difficulties in the way of the simultaneous transmission of two messages in the same direction, over the same line, were altogether insurmountable. A very little thought over the matter will show that the difficulties to be encountered in solving this problem are altogether of a different nature from those attending the question of duplex working, and, further, it is evident that if once these difficulties were overcome, the problem of quadruplex telegraphy would be solved by applying to our apparatus similar arrangements to those by which duplex telegraphy has already been rendered practicable.

It is obvious that, to send two messages at the same time, in the same direction, on the same wire, between two stations, two keys are required; and it is also obvious that with two keys, each having independently two positions, there are four combinations, which of course should each produce a different effect upon the receiving instruments at the distant end. Thus suppose we have two keys, which we will call A and B respectively, we shall have—

1st	combination.	Both keys at rest.
2nd	"	A depressed and B at rest.
3rd	"	B depressed and A at rest.
4th	"	Both keys depressed.

* Communicated by the Author.

There are two different ways of attacking the problem, namely—

1. To devise such an arrangement of the keys that each of the four combinations shall produce a different electrical effect on the line, and then to endeavour so to arrange the receiving instruments that these different electrical effects shall be rightly interpreted by them.

2. To endeavour so to arrange the receiving instruments that, with some four variations in the electrical state of the line, four combinations, analogous to those of the keys we have noticed above, may be produced; and then to devise some arrangement of the keys by which the desired electrical states of the line may be produced by their action.

I have only seen two systems described in any of the works on electricity or telegraphy that I have read. One is given by Blavier and the other by Sabine. In each of these it would appear that the inventors had set to work according to the first method, for in each the method of joining up the keys is practically the same, and intended to produce currents as follows:—

1. Both keys at rest. No current.
2. A depressed and B at rest. One unit of current.
3. B depressed and A at rest. Two units of current.
4. Both keys depressed. Three units of current.

All the currents being in the same direction.

This is the most obvious arrangement of the keys, and it will be seen, from the following descriptions of the methods, that in each of them the inventors have been successful in rightly interpreting the different signals sent; thus, supposing the local instruments at the receiving station to be Morse instruments, we find that—

1. When no current arrives, both Morses are at rest.
2. When one unit of current arrives, Morse A is acted upon and Morse B is at rest.
3. When two units of current arrive, Morse B is acted on, Morse A is at rest.
4. When three units of current arrive, both Morses are acted on.

So that at first sight the problem would appear to have been solved in each case: on examining the matter further, however, we shall find that false signals would be made during the changes from one combination to another, which, apart from another drawback we shall notice, would suffice to render the method useless.

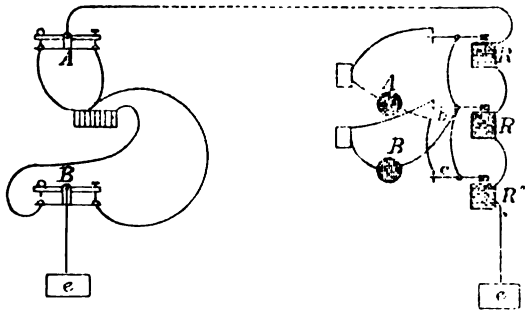
The method given by Blavier is as follows:— R, R′, R″ (Fig. 1) are three relays joined up one after another between the line and the earth at the receiving station.

Of these R is the most sensitive, and will work with one unit of current.

R' is rendered less sensitive by means of an opposing spring: it will not work with one unit of current, but it will with two.

R'' is rendered still less sensitive by means of a stronger opposing spring: it will not work with less than three units of current.

Fig. 1.

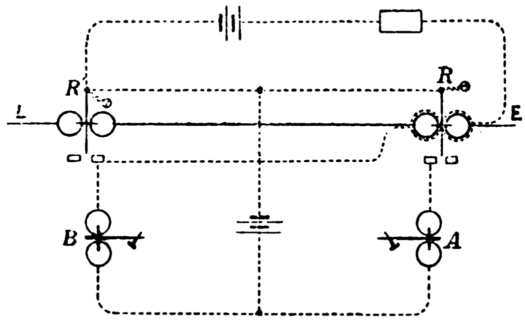


It will be seen that the Morse A is joined up in such a way that, so long as the relay R' is at rest, it will work whenever the tongue of relay R is acted upon by the current. So long, therefore, as the key A only is worked, and consequently only one unit of current sent into the line, the Morse A will indicate the signals given by the key A. When the key B is depressed it is evident that two units of current are sent into the line; consequently the current is strong enough to work both the relays R and R'. The relay R' in working completes the circuit of Morse B, and at the same time breaks the circuit of Morse A; thus, so long as only the key B is worked, the Morse B will indicate the signals given by the key B. Now suppose we depress both keys, there will be three units of current, and consequently the relay R'' will be worked as well as the others. It will be seen that when relay R'' is worked, the break in the circuit of Morse A which is caused by the working of relay R' is made good, and thus both Morses will be worked. So far all well, but now let the key B be raised; the current will be reduced to one unit, and consequently both the relays R' and R'' will be drawn back. Of course the circuit of Morse B will be broken, but so also will for an instant that of Morse A, for it is evident that the tongue of relay R'' will have broken contact with *c* before the tongue of relay R' can have made contact with *b*, and thus recompleted the circuit of Morse A. Thus at the change there will be a sudden interruption of the working of Morse A, not answering to any signal given by its key, and a confusion of signals must arise.

Added to this, however, the difficulty of keeping the three relays at proper states of sensitiveness would be almost insurmountable. The difficulty of the interruptions of the circuit in the intervals between the positions of rest and depression of the keys could be overcome by known methods.

The system given by Sabine was invented by Stark, of Vienna, in 1855. The method of connecting the keys was somewhat different from that shown above, but the result was exactly the same, so we will only concern ourselves with the receiving apparatus: this is represented in Fig. 2.

Fig. 2.



In this arrangement only two relays, of different degrees of sensitiveness, are employed. Relay R is the most sensitive, and will work with one unit of current; relay R' is less sensitive, and will work with two units of current, but not with one. When relay R' works, however, it not only completes the circuit of the Morse B, but also that of another circuit through an extra coil of the relay R, in such a direction as to oppose the action of the currents coming from the line, and thus to render it less sensitive, and only to be worked by three units of current in the line circuit.

According to this plan, whenever the key B is worked both relays will work, for it is not until the relay R' has made its contact that the sensitiveness of relay R will be reduced; consequently at every depression of the key B we shall have a momentary kick on the Morse A, not in accordance with any signal given by its key, and thus confusion of signals must result. Again, although we have only two relays to adjust as to sensitiveness, yet one of these has two states of sensitiveness, one of which, namely, that caused by the opposing action of the local current, would be even more troublesome than the adjustment of the third relay by means of a spring. Neither of these methods can therefore be said to offer any hope of practical success.

Having now examined the principles and learnt the defects of the old systems, I will endeavour to explain, as clearly as possible, the principle of the system by which I have achieved a practical success, and the line of thought which led to its discovery.

To begin with, then, I attacked the problem by the second method; that is to say, I said let there be four variations of current—how can I cause these four variations to produce on two Morse instruments the four necessary combinations, the apparatus to be so arranged that no kick shall be produced on either of the Morses, at any of the moments of change from one variation to another, and, also, that the adjustment of the arrangement shall not depend in any way on differences in the sensitiveness of relays?

This is the problem I set myself; for I took it for granted that when once this had been solved the arrangement of the keys to produce the required variations would be easily accomplished.

(To be continued.)

THE TELEGRAPHS OF NEW ZEALAND.

From the Eleventh Annual Report of the Acting Commissiouer of the New Zealand Telegraphs for the year ended June 30 last we learn that during the year, 917,128 telegrams of all codes were transmitted, being an increase of 164,299, or more than 17 per cent over the previous year. Taking into account the value of general government telegrams transmitted (£13,679 10s. 9d.), the total earnings of the department for the year amout to £69,536 12s. 3d., which, after deducting the cost of the signals department, maintenance of lines, &c., leaves a balance of £9460 13s. 4d. as interest upon the capital expended.

The number of telegrams transmitted during the year (917,128), compared with the number of interprovincial letters posted during the year, shows that 22·59 telegrams were sent for every 100 letters posted. The proportion is not quite so great as last year, but the fact that there is nearly one million increase in the number of letters posted as compared with the number of letters for the previous year should not be overlooked.

The number of money order telegrams sent during the year was 9650, representing a value of £46,489 19s. 10d., or an increase of 1649 messages, and of £8437 5s. 1d., as compared with the previous year. The commission collected by the Post Office was £1257 5s.; and after deducting £482 10s., due to the telegraph department as fees on the telegrams, there remained to the credit of the Post Office, as commission on exchange, £774 15s., or more than £1⅔ per cent on the amount transmitted. Dunedin, Wellington, and Christchurch, and their respective sub-offices, issued the largest number of orders; and Dunedin, Auckland, Wellington, and Christchurch paid the largest number.

To enable masters of vessels to ascertain the state of the weather prevailing at any port to which they might be bound, or at any intermediate port, the system of sixpenny telegrams, including reply, was introduced.

A like facility for obtaining news at a reduced rate was also granted to all Chambers of Commerce throughout the colony who might be desirous of acquiring for public information the arrivals and departures of shipping at the various ports. The consideration in this case asked for by the department was, that telegrams containing shipping intelligence, the same being positively for public and not private information, be paid for at the rate of 3d. per telegram for each vessel.

During the past year 456 miles of new lines, carrying a single wire, have been erected, and 988 miles of wire have been added to the original lines, making a total addition of 1444 miles of wire.

There are now opened to the public throughout the colony 127 stations, 21 of which have been opened during the past year, 6 being in the South Island, and 15 in the North Island.

At the close of the year 2986 miles of lines, carrying 6616 miles of wire, were in circuit, showing an increased mileage upon the previous year, in line 456, and wire 1444.

The nominal strength of the department, including linemen and inspectors, on June 30, 1875, was 509 against 388 of the previous year.

The duplex system of telegraphy, mentioned in the last annual Report, has been in successful operation on the No. 3 wire in the Cook Strait Cable since June 18, 1874, and the advantage of speedy communication consequent thereupon has been very obvious. Instruments are now ready, and the system will be immediately introduced on the No. 3 wire north to Napier, and on the No. 3 wire between Blenheim and Christchurch. With the additional wires erected between Napier and Wellington, it is anticipated that this will greatly facilitate the transmission of the increasing work now offering. It is proposed to introduce shortly the automatic system on some of the longer circuits, instruments for this purpose having just arrived from England.

It has become a matter for consideration whether an alternate Cook Strait Cable should not be laid, so as to avoid total suspension of telegraphic communication in the event of a breakage occurring to the present one—a contingency which, although remote, is nevertheless possible. Mr. C. Lemon, the General Manager of the department, to whose ability we attribute the continued and increasing progress of the telegraph system throughout the colony, points out the necessity for some action being taken in the direction indicated. He says:—

"The present Cook Strait Cable has now been submerged close upon eight years, and at the date of the last test for insulation (March 24, 1875) gave as good results as when first laid. This state of insulation may continue, so far as comparing previous tests taken monthly during the last six years is a guide, but the cable is liable to interuption, first, from a ship on a lee shore off Cape Terawiti, or in that vicinity, endeavouring to save herself by letting go her anchors and possibly fouling the cable with the same; second, by an earthquake causing a fissure in the bed of the ocean in a line at right angles to the lay of the cable, and thus causing it to part.

"It is for the commissioner to consider, in the event of interruption from either of these sources, whether it would not be prudent to have a second cable laid (containing either one or three wires), as soon as it could be obtained from England. I estimate the cost of a one-wire cable laid at £10,000.

"The present cable, owing to the introduction of duplex telegraphy, is capable of performing all the work which may be required of it for some time to come; but in the event of an interruption and

pending repairs, and without a second cable to fall back upon, the pecuniary loss to the department would be great, whilst the public would be much inconvenienced by the total suspension of telegraphic communication with the other island."

ELECTRICAL SCIENCE IN FOREIGN JOURNALS.

(This column is devoted to a list of Electrical Memoirs published in Foreign Journals. Those of importance will be either translated in full or given in abstract.)

Comptes Rendus Hebdomadaire des Seances de l'Academie des Sciences.

Vol. lxxxi., No. 13, September 27, 1875.

Electric Conductivity of Poor Conductors (Twelfth Note).—Count Th. du Moncel.—This has already appeared, having been forwarded to us by the author.

Les Mondes.

Vol. xxxviii., No. 6, October 7, 1875.

Electro-Magnets.—Count Th. du Moncel.—This appeared in our number of July 1, 1875, under the title of "Tubular Electro-Magnets with Multiple Cores."

Dingler's Polytechnisches Journal.

Second number for August.

The Magneto-Induction Machines of Siemens and Halske (Hefner-Alteneck System).—Dr. Zetzsche.—Will appear shortly.

Hotel Telegraph of Debayeux, in Paris.—This apparatus enables the guests to telegraph a number of the more common orders to hotel servants.

C. W. Siemens's Electric Pyrometer.—This is an abstract of a paper recently published by M. Siemens "On the Dependence of Electric Resistance on Temperature."

Electric Lighting of Workshops, &c.

First number for September.

A Simple Method of comparing the Hardness of different kinds of Steel Electro-Magnetically.—M. v. Waltenhofen.—When a hardened steel bar is drawn through a magnetising spiral, it is generally found that one-half is more strongly attracted than the other: this is due to non-homogeneity in hardness of the bar; thus a method of testing steel bars for hardness is suggested. Of the steels to be compared, bars of equal length and weight are procured; then one is hung vertically, with copper wire, from one end of a hydrostatic balance, which is then brought to equilibrium by putting weights in the scale. For the ordinary water-vessel a magnetising spiral is substituted, and the bar is allowed to hang to the extent of a half in the hollow part. If a current be forthwith sent through the spiral the bar will be drawn wholly in, and the balance will shake. To avoid this, the equilibrated bar is held with the fingers; then the circuit closed; then weights are put into the scale till they are felt to counterbalance the force which draws the bar into the spiral; then the fingers are withdrawn, and the bar is put in equilibrium, so that a small additional weight would suffice to draw it out of the spiral altogether. As the bar will not hang exactly in the middle of the spiral, but be attracted to one side when the current flows, a tube of smooth glass or brass should be put in as lining, to prevent friction. A rheostat and galvanometer are also necessary for regulation of the current. With 1 Bunsen element, 144 windings of a copper wire 3 m.m. thick (the spiral being 91 m.m. high and 3 c.m. wide), and an iron bar 10 c.m. long and 20 grms. weight, 87 grms. were necessary to overcome the attraction of the spiral: with a similar hardened steel bar 52 grms. were required. For steel of little hardness, or unhardened, numbers were obtained between these.

On Meidinger's Balloon-Element of Siemens and Halske, in Berlin.—This consists of an outer glass vessel, narrowing somewhat about half-way down, and a smaller inner glass on the bottom of it. On the edge of the former rests a glass balloon with its mouth downwards, and a cork holding a small glass tube in the mouth. In the small glass vessel is a copper (or brass or lead) cylinder, with which is connected a caoutchouc-covered wire of copper. At the narrowing of the larger glass there is a zinc cylinder with which an uncovered copper wire is connected; and the two wires pass out through grooves in the glass balloon. The outer glass is first filled to 7 or 8 c.m. from the brim with soft water, and 80 to 90 grms. Epsom salt is added. After solution of this, the small glass is put in, then the copper cylinder, then the zinc, then water till the liquid surface is about 3 to 4 c.m. from the rim. The balloon is filled with pieces of blue vitriol, soft water is added, and, by shaking and inclining the vessel, air is removed as much as possible; then the balloon is filled to overflow with water, and the cork with glass tube inserted, so that the surplus liquid comes out by the tube. Then with the finger you stop the glass tube, invert the balloon over the glass vessel, and, when its mouth is in the liquid, remove the finger. It is important that the cork fit very accurately in the mouth and round the tube. The glass tube reaches to 1 to 2 c.m. from the bottom of the small glass. From time to time some of the Epsom salt solution (which is more and more concentrated) must be removed, and water substituted; and crystals may be prevented

forming on the larger glass surface by previously coating it with a solution of gum arabic.

The Copper-Steel Wire for Telegraph Lines from the Manufactory of Siemens Brothers, Woolwich.

Berichte uber die Verhandl. der Konigl. Sachs. Gessellschaft der Wissenschaften, Leipzig. 1874, iii., iv., v.

Summation of Electric Stimuli of the Skin.—M. Stirling.

Thermo-Electric Properties of Lime-spar, Beryl, Iodocrase (Vesuvian), and Apophyllite.—M. Hankel.

Zeitschrift der Œsterreichischen Gesellschaft fur Meteorologie. Bd. x., No. 15.

Meteorological and Magnetic Observations in China.

Archiv. fur Anatomie, &c. Heft 2, 1875.

On a Physiological Action of the Capillary Electric Current.

Sitzungsberichte der Mathematisch-Physikalisch. Classe der K. V. Akad. der Wissenschaften zu Munchen. 1875, Heft 2.

(Proceedings of Munich Academy.)

Electric Influence on Liquids.—M. Wüllner.—Reserved for separate note.

Double Maximum in the Frequency of Thunderstorms during the Summer Months.—M. von Bezold.—The results of this investigation are thus formulated:—Phenomena of thunderstorms show in general, during the summer months in the northern hemisphere, two maxima. These maxima approximate nearer to each other the further we go north. But not only can they be decisively proved for Germany, but they are distinctly recognisable (taking the principle of five-day sums) even in Barnaul and St. Petersburg. Among the places examined there is only one which showed but one maximum, and this is Katharinenburg, the climate of which is less influenced by the meteorological phenomena of the tropics than that of any other place taken into consideration. [In the tropics it has been shown that strictly there is summer twice in the year. These two maxima of temperature, which, as you remove from the tropics, approach each other very quickly, merging into one another in the high latitudes, appear much more strikingly in the frequency of the thunderstorms. Thus the phenomenon in question may be regarded as an echo of the two tropical summers, or heat maxima.]

Journal de Physique. September 1875.

Some Experiments on Electrostatic Induction.—M. Govi.—These are to show that induced electricity of the first kind has potential. An electrified spherical body is supported under two pith balls, which are hung by linen thread from an insulated ring. At the very first the balls diverge, and the divergence increases when they are made to communicate with the earth. If this divergence (says M. Govi) arose from curvilinear induction by the inducing sphere, as has been supposed, it should cease or diminish, on the induction being suppressed; but this is not the case. On discharging the inductor with an uninsulated metallic point, the two pendula may be made to separate further. The reason is that the inductor, far from separating the balls by curvilinear induction, exercises on them an attraction which tends to bring them together. If we understand by *electric potential* the effort of electrified bodies to approach or withdraw from each other, the separation of the small pendula should still prove the potential of the induced electricity opposed to the inducing, were it even demonstrated that we must attribute it to what Faraday has denominated curvilinear induction. The potential of the induced electricity is still more distinctly manifested when the induced body is terminated by a fine point turned directly towards the inductor. If, in this case, the air being very dry, and the supports of the induced body perfectly insulating, the induction be allowed to act a few seconds, one finds that immediately after discharge of the inductor the induced body retains a perceptible charge of electricity of the same name with that of the inductor. All the other phenomena which have produced in some minds the contradictory idea of an induced electricity without potential are easily explained if we take into account the influence exercised on the inductor by bodies, insulated or not, which are brought near the induced.

Electroscope with Very Sensitive Dry Piles: its Use in some Experiments on Electricity of Contact, and on the Electromotive Force of Heat.—M. Righi.—Reserved for separate note.

This number also contains several abstracts of papers from other journals on electrical subjects.

The Annual Soirée of the Society of Telegraph Engineers will be held at the end of the present month.

TO CORRESPONDENTS.

*** Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which "The Electrical News and Telegraphic Reporter" is the organ, will always command attention. Literary communications and books for review should be addressed to the Editor; business communications to the Publisher Boy Court, Ludgate Hill, London, E.C.

In consequence of the length of the Memoir of Sir Charles Wheatstone we are obliged to leave over "Notes," "Correspondence," "Commercial Notes," and "Patents."

London Printed and Published by the Proprietor, WILLIAM CROOKES, at the Office, Boy Court, Ludgate Hill, E.C. November 1, 1875.

THE

ELECTRICAL NEWS

AND

Edited by Wm. Crookes, F.R.S., &c.] TELEGRAPHIC REPORTER. [Registered for Transmission Abroad.

Vol. 1.—No. 18.] November 15, 1875. [Price, 3d. Post Free, 3½d.

CONTENTS.

THE ELECTRICAL NEWS.

Vol. I. No. 18.

SIR WILLIAM THOMSON'S REPORT TO MESSRS. SIEMENS BROTHERS ON TESTS OF DIRECT UNITED STATES CABLE,

Taken at Ballinskelligs Bay Station, September 16 and 17, 1875.

(Concluded from page 208.)

At the conclusion of the "zinc to cable" test, the cable was put to earth and kept so for two minutes, till 12.36, when a similar series of tests with copper to cable was commenced, always with the same battery of 20 cells. These tests were much disturbed by another storm of earth-currents (not quite so severe, however, as that of the preceding morning), which came on very suddenly about the fourth minute of electrification, and nearly stopped the leakage current (giving an apparent insulation-resistance of 7,000,000). The new ballistic test was then applied, and continued in alternate minutes as before. The first ballistic deflection gave an apparent resistance of 5,000,000, and the second actually showed an increase of potential (relatively, of course, to the Ballinskelligs earth) during the minute of insulation. Then came ten minutes of comparative tranquillity, till 12 h. 52½ m., when the leakage current from the battery was rapidly reduced to zero and reversed, and a quick succession of violent pulsations supervened for about a minute and a half, throwing the spot of light alternately off scale to right and off scale to left, at irregular intervals of ten or fifteen seconds. About 12.56, there being still great deflections, but not so rapid pulsations, a shunt was applied which allowed the amounts of the deflections to be observed, and showed them to range frequently from ten to forty times the proper leakage current, some in the contrary direction to it, and some in its own direction. The disturbance diminished gradually till 1 h. 7 m. a.m., when the cable was discharged to prepare for measurements of capacity and copper resistance. Notwithstanding the very disturbed state of the line, the means of the regular observations taken between 12.39 and 12.53 gave satisfactory results in respect to insulation resistance. Thus the mean of 24 deflections observed in the ordinary galvanometer test during that interval was 112·2, which gave for insulation resistance 2,585,000 Siemens units, this being for the time from the end of the fourth minute to the end of the sixteenth minute of electrification. The ballistic deflections observed were—

End of 5th minute	. .	+ 52 divisions.
" 7th "	. .	− 10 "
" 9th "	. .	+ 80 "
" 11th "	. .	+160 "
" 13th "	. .	+ 92 "
" 15th "	. .	+102 "
" 17th "	. .	+ 62 "
		538÷7
Mean	. . .	77

This with the ballistic constant, determined in the manner explained above, gives 3·52 megohms, or 3,690,000 Siemens units, for the insulation resistance.

The measurement of electrostatic capacity described above was next repeated, and the previous result confirmed, but there was not time to attain to more minute accuracy in the adjustment.

Lastly, the copper resistance was measured by the simple galvanometer method. The insulation galvanometer, quickened three- or four-fold by a magnetic adjustment (which I had used also in the insulation tests), and with a shunt of 20 Siemens units on its coil, was put in circuit between line, battery, and earth, and the deflection was observed and recorded every ten seconds during the whole time of the test, which was from 1 h. 36½ m. to 1 h. 58 m. As was to be expected, large and rapid variations of the deflection were continually taking place on account of earth-currents. The direction of the earth-current was from east to west the whole time, as was shown by the "copper" current being always greater and the "zinc" current less than the true mean concluded from the observations. It increased gradually (but with some slight backward pulsation) from the beginning (1 h. 26½ m.), when its amount was that due to a difference of potentials between the Ballinskelligs and Torbay earths, equal to 1·7 of a cell (one cell and seven-tenths), till the end (1 h. 58 m.), when it was more than five times as strong, and corresponded to nine cells—the Irish earth positive relatively to the Nova-Scotian earth the whole time.

To measure the copper resistance, a time of comparative tranquillity was chosen, a reading taken, and then as quickly as possible the galvanometer short-circuited, the battery reversed, the galvanometer circuit reopened, and a fresh reading taken. Half the space travelled by the spot of light from the first reading to the second

is taken,* as being the deflection which would be produced by the battery applied in either direction were there no earth-currents. This was done seven times, and the half-ranges found were as follows :—

235
231
229½
234½
231
235
230

Mean ... 232·3

At 2 h. 2 m. I found that the same battery applied in the two directions through the galvanometer and 7300 Siemens units gave 232 divisions on one side of zero and 233 on the other—mean 232·5. Hence the copper resistance to be inferred from the observations is—

$$7300 \times \frac{232{\cdot}5}{232{\cdot}3}, \text{ or } 7306 \text{ Siemens units.}$$

Summary of Tests of Sept. 16 *and Sept.* 17.

Insulation Resistance—

Of whole cable of 2420 knots, in 2nd and 3rd minutes, 2¼ millions Siemens units, or 5445 millions per knot; from 4th to 24th minutes, 3½ millions Siemens units, or 8470 millions per knot.

Copper Resistance—

Of whole line, 7300 Siemens units, or 3·02 per knot.

Electrostatic Capacity—

Of whole line, 991 microfarads, or 0·4095 (say 0·41) per knot.

Throughout the preparations and observations required for the tests which I have now described I received skilful and efficient assistance from your electrician, Mr. Ebel, and his assistant; and I desire to take this opportunity of expressing through you my thanks for the patience and care with which they went through the somewhat irksome and tedious series of operations which I had to ask of them.

In conclusion, I am glad to be able to say that my tests proved the cable to be in perfect condition as to insulation, and showed its electrostatic capacity and copper resistance to be so small as to give it a power of transmitting messages, which, for a transatlantic cable of so great length, is a very remarkable as well as valuable achievement.

* Supposing there to be no instrumental error, the sole error in this process is that depending on the *change* of earth-current between the first and second reading, hence the importance of quickness, and the value of the "dead-beat" galvanometer for such observations. So far as the cable is concerned, five seconds (as I find from my mathematical theory) is amply sufficient from the instant of reversal to the second reading to secure that there be no sensible error on account of the current not having become perfectly uniform from end to end. But far more than five seconds is required to get the second reading, on account of the swinging of the galvanometer needle when the customary "astatic mirror" is used. With the dead-beat galvanometer the second reading is easily taken within five seconds of the first.

A NEW RELATION BETWEEN ELECTRICITY AND LIGHT: DIELECTRIFIED MEDIA BIREFRINGENT.

DR. JOHN KERR, Mathematical Lecturer of the Free Church Training College, Glasgow, contributes a paper under the above title to the November number of the *Philosophical Magazine*. The thought which led the author to the experiments which are detailed in the paper was "that if a transparent and optically isotropic insulator were subjected properly to intense electrostatic force, it should act no longer as an isotropic body upon light sent through it." At present the author has confined his attention to solid dielectrics, reserving the case of liquids for a second paper. The principal results of the experiments are summarised as follows :—

When plate glass is intensely dielectrified, and traversed by polarised light in a direction perpendicular to the lines of force, it exerts a partially depolarising action upon the light, giving an effect which is much more than merely sensible in a common polariscope. There is a good regular effect when the plane of polarisation is at 45° to the lines of force; no regular effect when the plane of polarisation is parallel or perpendicular to the lines of force. Electric force and optical effect increase together. The optical effect of a constant electric action takes a certain time (apparently about 30 seconds in the author's observations) to reach its full intensity, which it does by continuous increase from zero; and it falls again slowly to zero after the electric force has vanished. There is as good an effect with a rapid succession of contrary (Ruhmkorffian) electrisations as with a continued (Ruhmkorffian) electrisation in one direction.

The dielectrisation of plate glass is equivalent optically to a compression of the glass along the lines of electric force. Dielectrified glass acts upon transmitted light as a negative uniaxal with its axis parallel to the lines of force.

The author has also experimented upon the dielectric of resin and the dielectric of quartz: he considers it proved that dielectrified quartz (like glass) acts upon transmitted light as if compressed along the lines of force, while dielectrified resin (unlike glass) acts as if extended along the lines of force.

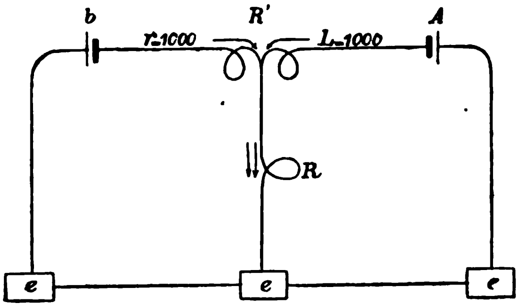
ON THE TELEGRAPHIC PROBLEMS OF DOUBLE SENDING AND QUADRUPLEX TELEGRAPHY.*

By G. K. WINTER.

(Concluded from page 210.)

IN Fig. 3 let L be the line with a resistance say of 1000 units, and let *r* be an artificial resistance of the same amount. Let *b* be a local battery, and A a battery at the distant station, of equal strengths, and sending their currents in the directions indicated by the

FIG. 3.

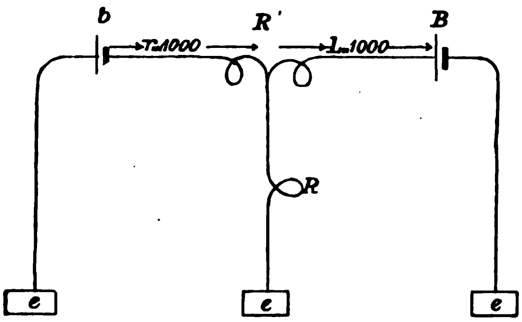


arrows; *e*, *e*, *e*, are earth plates. R' is a relay wound differentially, and R is another relay, not wound differentially, but connected between the middle point of R' and earth, as shown in the figure.

It is evident that the two currents will neutralise each other's effect on the relay R', but that they will both flow through R in the same direction. R' will evidently not work, but R will.

Again, let Fig. 4 represent the same arrangement, except that the direction of the battery B is reversed, as shown by the arrows. Then the currents will flow in the same direction through the two coils of the differential relay R', which

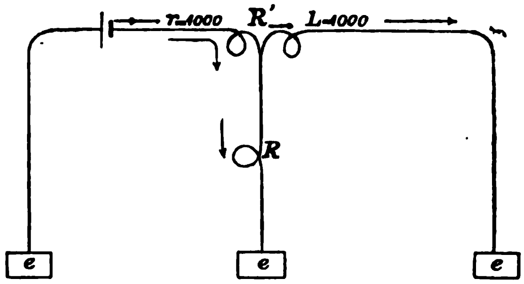
FIG. 4.



will consequently work, whereas no current will flow through R, as the potential of the circuit at the centre of the differential relay will be zero, the batteries being equal in power, and the resistance equal on each side of this point. Thus in this case the relay R' will work, but not the relay R.

Next, let us have no battery applied at the sending station, but the line joined to earth, as shown in Fig. 5.

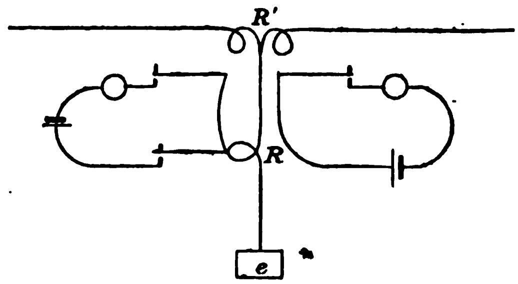
FIG. 5.



It is now evident that both relays will work, for a large portion of the current from *b* will flow through R to earth. Thus with three variations of current coming from the sending station we can produce three of our four combinations. It remains to be seen how we can produce the fourth.

Let us suppose the differential relay R' to have two tongues, and let the connections be made as shown in Fig. 6. Further, let this relay be polarised, and let both its tongues be worked by a current in the direction shown by the arrows in Fig. 5.

FIG. 6.



We must also suppose that when in a state of rest—that is, when no current is passing through the relays—the tongues will be in the positions shown in Fig. 6.

Things being thus arranged, let a current from S be sent, as show in Fig. 7.

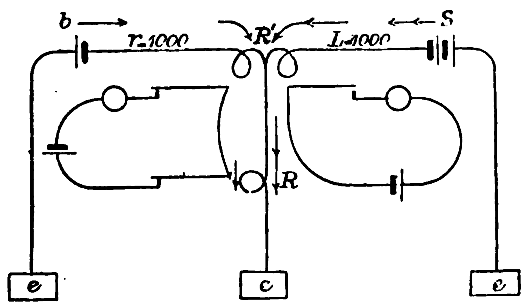
We shall then have a current running through one coil of R' not only in a direction opposed to that from *b*, but also of double the strength, and consequently the resultant magnetic effect of the currents on this relay will be to give it a polarity which will be opposed to its working; thus not only is the tongue *t'* allowed to fall away from its contact, but is held in that position, while the tongue *t* is also forced away from its contact-point, against which it leans

* Communicated by the Author.

during all the other variations of the current received from s.

Hitherto we have supposed the resistances on each side of the differential relay to be equal, but it will be seen at once that we may reduce the resistance r if we reduce the number of cells in the battery b in the same proportion: we may thus easily reduce this battery to one or two cells.

Fig. 7.



To recapitulate then, we find that—

1. If we have two units of copper current from s the sending station—that is, in the direction shown by the double arrow in Fig. 7—both tongues of the relay R' will be open, so that, notwithstanding that the tongue of relay R is closed, the circuits of both Morses will be broken, and those instruments consequently at rest.

2. If we have only one unit of current flowing in this direction from the sending station, the currents flowing through R' will balance each other, and consequently the tongue t will go to its position of rest,—that is to say, against its contact stud,—and as the currents flowing through R still cause its tongue to remain against its contact stud, we shall have the local circuit of Morse A completed, and therefore that instrument will work. The tongue t' of relay R' will, on the contrary, remain in its position of rest,—that is, against its insulated point,—and consequently the circuit of Morse B will be opened, and therefore that instrument will be at rest.

3. If we have one unit of zinc current—that is, as shown in Fig. 4—we shall have both tongues of relay R' closed, but the tongue of relay R will be opened, as that relay will have no current passing through it, and its tongue will therefore go to its position of rest against its insulated point. We shall therefore have the circuit of Morse B closed, but that of Morse A open.

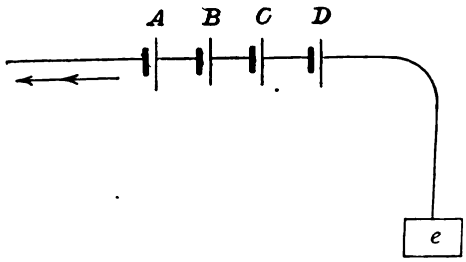
4. If no current arrives from s all the tongues will be closed by the action of the current in the local circuit, and consequently both Morses will work.

At the sending station, then, we want such an arrangement of two keys as shall produce the following variations of current by their four combinations:—

1. A copper current of two units when both keys are at rest.
2. A copper current of one unit when key A is depressed.
3. A zinc current of one unit when key B is depressed.
4. No current when both keys are depressed.

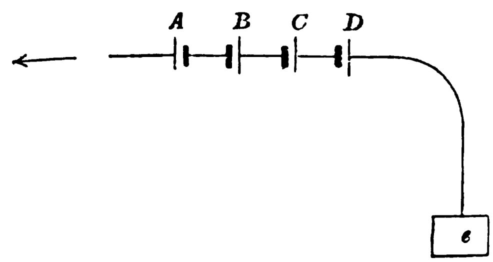
There are several ways of accomplishing this; perhaps the best is as follows:—

Let us suppose the full battery to consist of four cells (any multiple of that number would do as well). Let us represent them thus:—



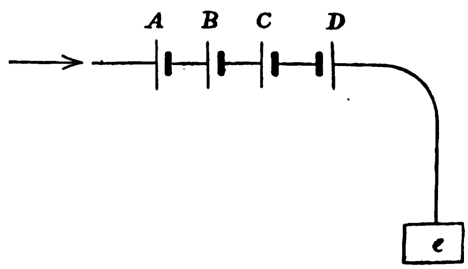
Let this be supposed to give two units of copper current to line.

Now suppose one of them, A, to be reversed by a reversing key. We shall have—



Thus A and B neutralise each other, and we shall have one unit of copper current to line.

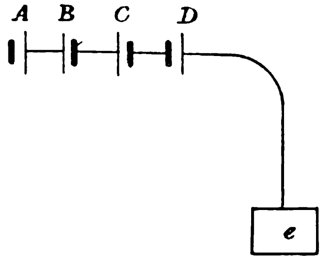
Next, let us suppose A, B, and C to be reversed by the depression of the other key; then we shall have—



or one unit of zinc current to line.

Lastly, let us suppose both keys depressed,

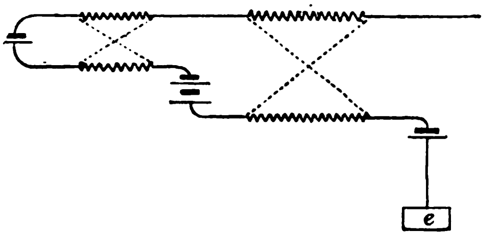
then A, which is reversed by the first key, will be set right again, and we shall have—



or B and C will neutralise A and D, and we shall have no current to line.

The following figure is a conventional mode of representing the action of reversing keys, and will doubtless be understood :—

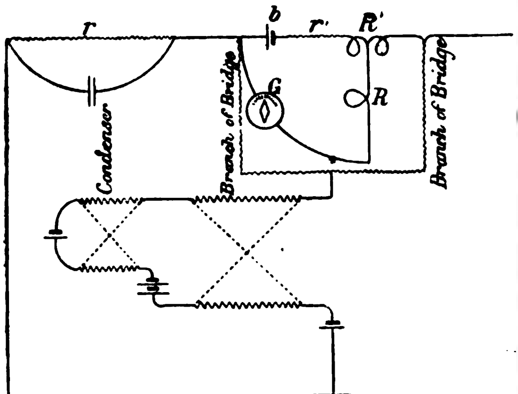
Fig. 8.



The sinuous lines show the connections when the keys are at rest, and the dotted lines show them when they are depressed.

We have now to show how this system may may be made into a quadruplex system by the application to it of the duplex principle. There are two ways of doing this ; perhaps in practice the following will be found the best :—

Fig. 9.



r and r' are adjustable resistances, and I think the rest explains itself.

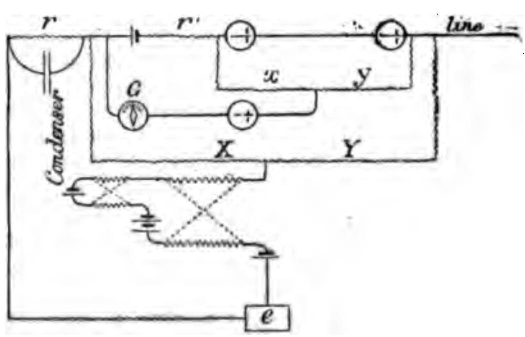
With regard to adjustments, let a galvanometer, G, be inserted, as shown in Fig. 9; request the distant station to depress his key B ; then adjust r until depressing either of your keys makes no alteration in the deflection of your galvanometer. This being done, adjust r' until the deflection itself becomes *nil*.

There are two or three obvious modifications of the arrangement of the receiving apparatus. For instance, we may connect the two relays one after another in such a way that the tongue of R will be worked by a copper current from the distant station, while those of R' are worked by a zinc current, and then having the local battery connected through extra coils wound on the relays, and in each case tending to cause the tongues to make contact with their respective contact-points ; or we may abandon the local battery altogether, and substitute a bias in favour of making a signal by the adjustment of the position of the tongues between the poles of the electro-magnets. We sacrifice, however, by these modifications, the very simple means of adjusting the arrangements which we have just described.

The following is a modification, however, which will probably prove an improvement in some respects. Instead of winding the relay R' differentially, we may substitute the Wheatstone bridge principle, and, further, we may use two distinct relays instead of one relay with two tongues. This modification will enable us to place the two relays, by means of which signals are produced upon Morse A, near that instrument, so as to be kept in adjustment by the clerk attending to it ; while for the same purpose the other relay may be placed near the Morse B. The arrangement under this modification is shown in Fig. 10, in which x and y are the branches of the last-named bridge, and X and Y the branches of the bridge for making the system a duplex arrangement.

We may also, even while using two distinct relays instead of a relay with two tongues, wind each of them differentially instead of using the branches x and y, but the bridge arrangement has certain advantages which lead me to prefer that system.

Fig. 10.



The form of double tongue relay that I have used for this arrangement is the same as that

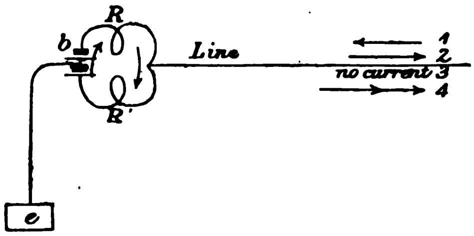
used in applying my duplex method to intermediate stations.

The double-sending arrangement described in this paper was worked with perfect success between Salem and Madras, a distance of 206 miles, on the 16th of April, 1875. Unfortunately circumstances prevented my carrying out the quadruplex working on an actual line about the 11th of August, when it was successfully worked on a loop line of 80 miles in length.

A second method of double sending, which I have successfully worked, follows almost as a matter of course from the system previously described.

Let *b* be a battery, and R and R′ two relays, joined up with earth and line in the manner shown in Fig. 11, Let S be the distant station,

Fig. 11.

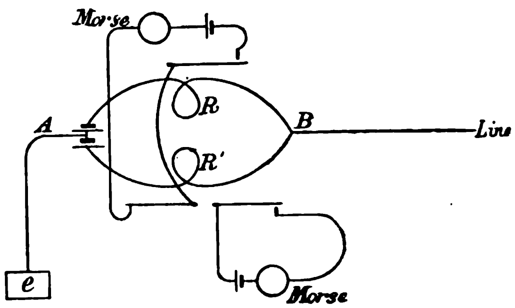


and let the four combinations of the keys at that station produce the currents represented by the arrows, &c., opposite 1, 2, 3, and 4 respectively. The current represented by the arrow opposite 1 will aid the local current through R′, but will neutralise that in R. Again, the current represented by 2 will aid the local current in R, but will neutralise that in R′. No current, represented by 3, will simply allow the local current to flow through both relays; and the double current represented by 4 will not only neutralise the local current in R′, but will cause a current in it in the opposite direction to that in which the local current is flowing. Let both relays be polarised, and so connected as to be worked by the local current. If now R′ be a relay with two tongues, the position of rest of one of them being against the insulated stud, and that of the other against the contact-point, while the position of rest of the tongue of the relay R is against the insulated stud, and the tongues joined up as shown in Fig. 12, we shall have exactly an analogous action in the relays to that described in the first part of this paper. This system, moreover, possesses certain advantages over the system previously described; it is simpler in theory, requires less battery power, and necessitates neither a differentially wound relay nor a bridge arrangement.

N.B.—The tongues are shown in their positions of rest.

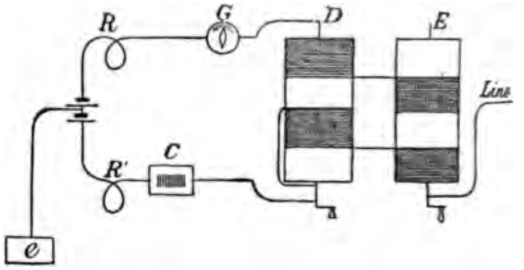
This system works exceedingly well, and of course the same arrangement of keys will suit either method. In order to duplex this system we join the two branches of the bridge to the points A and B, and put a resistance-coil between A and earth, adding condensers to this coil if necessary.

Fig. 12.



It is very desirable that the currents should be properly balanced in the relays R and R′, and it is also evident that the resistance of the two branches in which they are placed should be equal. In order to secure these conditions I make the following arrangement:—

Fig. 13.



R and R′ are the two relays as before. C is a resistance-coil for coarse adjustment, G a galvanometer, and D and E are two barrels of a rheostat, by which the finer adjustments are made; the barrel D is of ebonite or other insulating material, and the barrel E is of brass or other conductor. By turning the barrels equal increments or decrements are effected in the resistances of the two branches.

We will now analyse the changes in the positions of the tongue of the relays which are caused by the action of the keys.

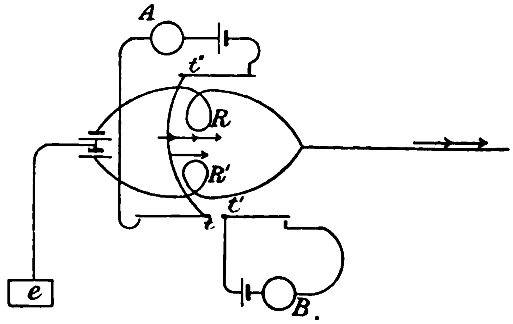
Fig. 14 shows the position of the tongues and the direction of the currents when both keys are at rest. It is seen that both the tongues *t* and *t′* of relay R′ are open, while the tongue *t″* of relay R is closed. Both local circuits are therefore open.

Now suppose that key at the distant station to be pressed which sends one unit of zinc current into the line (see Fig. 15).

The current in R is simply reduced from three units to two units, so that the tongue *t″* continues closed. The current in R′ is neutralised,

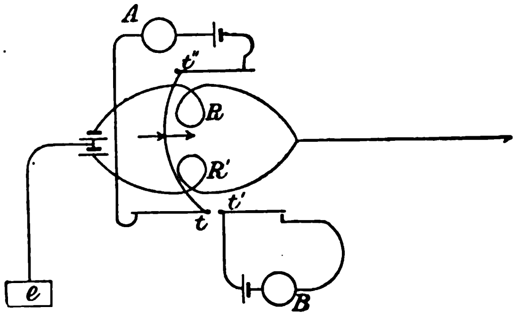
so that the tongue t falls to its position of rest against the contact-point, and thus completes the circuit of Morse A. The tongue t' remains

Fig. 14.



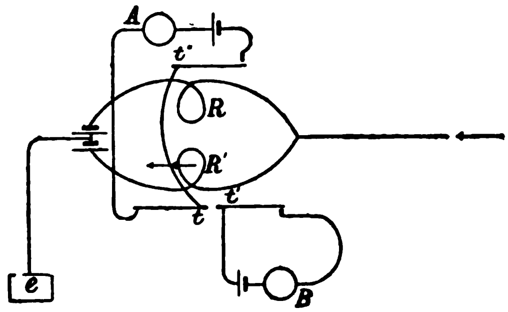
against the insulated stud, as that is its position of rest: the current of Morse B is therefore open. When the key is raised the tongue t simply falls back against the insulated stud, and thus breaks the circuit of Morse A. We will call this key A, and we see that it works the Morse A when it alone is worked.

Fig. 15.



Now let the key B be depressed, sending a copper current of one unit into the line (see Fig. 16).

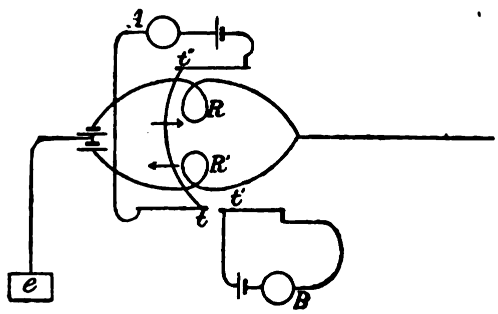
Fig. 16.



The current in R is now neutralised, while that in R′ is two units in the direction of its working. The tongue t' closes the circuit of Morse B. The tongue t also comes against its contact-point, but the tongue t'' of relay R is opened, and it is evident that the tongue t has to perform a journey before it reaches the contact-point, while the tongue t'' breaks the circuit as soon as it begins to move, so that a little care in the adjustment is all that is required to prevent any kick at this change. The same may be said when the key B is raised, and the tongues go back to their normal position; the tongue t'' has to perform a journey before it reaches the contact-point, while the tongue t breaks the circuit directly it begins to move. These are the only changes which involve the motion of more than one tongue at a time, and it is clear that a kick can only be produced in the event of one of the tongues t or t'' reaching its contact-point before the other breaks the circuit by commencing to move to the insulating stud. Practically a little care is necessary to prevent this kick.

Next, let us suppose the key A to be kept depressed, and that we work with key B. The current in the line, which is one unit of zinc current when the key B is up, becomes zero when key B is depressed. The position of the tongues when key A alone is depressed is shown in Fig. 15; both t and t'' are closed, and only t' is open. The reduction of the line current to zero produces the effect shown in Fig. 17.

Fig. 17.



Thus the working of the key B while A is depressed simply causes the closing and unclosing of the circuit of Morse B by the action of the tongue t'.

Lastly, suppose the key B to be depressed and the key A worked. The state of things when B alone is depressed is shown in Fig. 16, in which both tongues of relay R′ are closed, and only the tongue t'' of relay R is open. It is evident that the reduction of the line current to zero by the depression of key A will simply cause the closing of the circuit of Morse A by the tongue t'', and this tongue alone will fall back and open the circuit of Morse A when the key is raised.

The new arrangements hitherto described, with the exception of the modification mentioned on page 217, were designed under the impression that the difficulty of keeping relays in different

degrees of sensitiveness was great, and with a view of removing that drawback amongst others. I find, however, that the modification alluded to above works very well, and that my idea of this difficulty was rather exaggerated. In this arrangement the equating battery is dispensed with, a mechanical or magnetic bias being substituted for it, and the two relays are placed one after the other between line and earth.

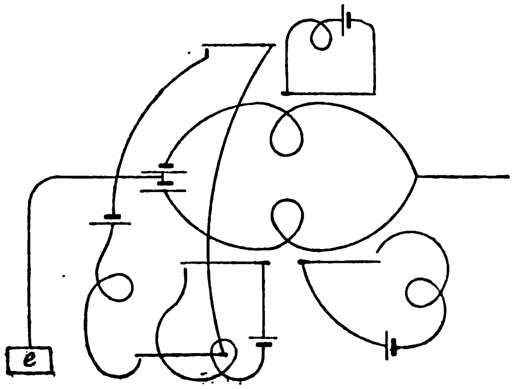
This plan admits of two obvious modifications which deserve attention: thus, instead of a double-tongued relay we may use two single relays, as in a modification before alluded to; or we may reverse the single relay and one of the tongues of the double-tongued relay, and then use this relay for working one Morse, and the single relay for working the other. My experiments, however, so far have led me to prefer the plans with an equating battery.

We have now only to consider, with reference to this system, the effect of the electrostatic induction of the line on the receiving instruments. I have found, in practice, that whereas there is no difficulty while working through resistance-coils in preventing the kick which is made if tongue t makes contact before the tongue t' has broken contact, and *vice versa*, during the working of that key which changes the current from $+2$ to -1, and *vice versa*, yet when working through a long land-line—especially when working with quadruplex connections—I have found that this is not so easy. The action of the inductive capacity of the line is to retard these changes, whereas when working through resistance-coils the changes take place suddenly. This difficulty may be overcome in either of two ways:—

1. You may put the wire of an electro-magnet as a shunt on the apparatus. The extra currents generated in the electro-magnet will neutralise the static discharges from the line, which are the cause of the retardation.

2. Instead of allowing the tongues of the relays themselves to complete the local circuit, you may cause them to complete the circuits of

Fig. 18.



other relays in the way shown in Fig. 18, and then utilise the tongues of these secondary relays for working the local circuit. Both these methods have been successfully applied in my experiments.

Finally, I may mention that in quadruplex working the effect of the static induction of the line on the instruments at the sending end may be more economically and quite as effectually neutralised by making that branch of the bridge which leads to the resistance-coils an electro-magnet with a movable core, as by using a condenser with the resistance forming the artificial line.

Since the first part of this paper was written an account has been published of two American systems, of which one—namely that of Prescott and Edison—is said to have worked well. In this system one key in its position of rest puts, say, 50 cells of copper current to line, but when depressed the current is changed to 150 cells in the same direction: the other key simply reverses the direction of the currents sent by the first key: thus, calling the first key A and the reversing key B, we have the following currents:—

	Current.
1. Both keys at rest	$+50$
2. A depressed and B at rest...	$+150$
3. B depressed and A at rest...	-50
4. Both keys depressed... ...	-150

At the receiving station there are two relays connected one after the other between line and earth. Of these, one is a polarised relay, working only with a zinc current, but is capable of working with as low a power as 50 cells; the other is an electro-magnet which requires 150 cells to work it, but is independent of the direction of the current.

Thus, calling the polarised relay B and the electro-magnet A, we have—

1. $+50$ will not work either relay.
2. $+150$ will work A, but not B.
3. -50 will work B, but not A.
4. -150 will work both relays.

So far all well, but suppose key A depressed, giving current $+150$, and working the electro-magnet; now press key B, reversing the current, and making it -150. The electro-magnet passes through a zero of magnetisation, and consequently must give a kick. To remedy this the inventors use a condenser, connecting one of its armatures to one side, and the other to the other side of the relays; the discharge from this condenser at the moment of change is said to remedy this defect: it seems to me, however, that the evil moment is simply postponed, for the electro-magnet must pass through the zero point of magnetisation, and consequently there must be a moment of no attraction for the armature.

In conclusion, I must mention that the single-tongued relays used in my experiments were polarised, but of a form differing from Siemens's, which unfortunately does not answer. They were designed some years ago, and are exclusively used on the Madras Railway lines. Two electro-magnets are placed horizontally, with their dissimilar poles facing each other. The armature is of soft iron and is polarised in the centre, so that each of its ends has the same polarity. The ends of the armature play between the poles of the electro-magnets, and the axis about which it moves is in the centre of the jaws of the polarising magnet. One of the ends of the armature is prolonged and plays between the contact-points, while the other carries a counterpoise. The electro-magnets are polarised in the same way as in Siemens's relays.

I find this relay is quicker in its action than Siemens's, and it is the only form I have used in any quadruplex trials, except Siemens's, which only answers when secondary relays are used, as in Fig. 18. I should say that D'Arlincourt's relay would probably be very likely to succeed.

It is probable that secondary relays will always be found desirable, as less battery power is required when they are used. They can, of course, be applied in any of the modifications described.

NOTES.

Direct telegraphic communication is now established between Martin Garcia and Buenos Ayres. The new telegraph was inaugurated by the Minister of War asking the President of the Republic to send the first telegram. Mr. Charles Burton, the Director General of Telegraphs, Mr. Crowley, Electrician of the Torpedo Division, and nearly all the Foreign Ministers were present.

With the object of providing Indian students and telegraphists with a channel for the free exchange of ideas and the discussion of all questions relating to electricity, a bi-monthly magazine has been started under the title of "The Indian Telegraphic Journal." In the first number 22 pages are devoted to arithmetic, algebra, geometry, trigonometry, and chemistry, and the remaining 15 to subjects connected with electricity. To attain success the promoters of the new periodical will doubtless find it necessary either to alter the title or to devote the greater part of the journal to electrical science.

It was decided a short time ago to institute a course of instruction for the more advanced telegraph officials in the *Polytechnikum* at Dresden. The arrangements have now been completed, and we learn that Dr. K. E. Zetzsche, of Chemnitz, has been invited, and has accepted, the post of professor. Dr. Zetzsche has already made for himself a good name as a theorist; he has taught mechanics, mathematics, &c., in Chemnitz since 1858, and has come to the front by his literary activity, especially in the domain of telegraphy. Besides the numerous papers from his pen in various serials, we may mention the following independent works: "Copying Telegraphs, Type-printing Telegraphs, and Duplex Telegraphy," Leipzic, 1865; "Catechism of Electric Telegraphy," Leipzic, fourth edition, 1870, (a fifth edition appeared in 1873); "Short Sketch of the History of Electric Telegraphy," Berlin, 1874; and "The Development of Automatic Telegraphy," Berlin, 1875. But Dr. Zetzsche has also had practical experience, for we believe we are correct in saying that from 1856 to 1858 he held a position as telegraph official in the Austrian State service. Whilst the Polytechnikum has already, under the guidance of Dr. Zenner, taken a prominent position for instruction in other branches, there is every reason to expect that it will, through the call of Dr. Zetzsche, acquire note also in the department of telegraphy.

In the Electrical News of August 12th we announced that an Exhibition of all kinds of Electrical and Telegraphic Apparatus would probably be opened in Paris in December. Finding it impossible to organise the Exhibition in so short a time, the promoters postponed the opening of the Exhibition until July, 1877, when it will be opened at the Palais de l'Industrie. Count Hallez d'Arros has been appointed Director-General, and the President of the French Republic is at the head of a Committee of Patronage. The Exhibition will be divided into a number of groups, particulars of which we had prepared for publication, but in consequence of the demand on our space we are compelled to reserve them until our next notice of the proceedings of the Committee.

In the Postmaster-General's Report for 1874 we read:—"There has again been a large increase in the amount of postal telegraph business, the number of messages (exclusive of newspaper telegrams) having last year been above 19,000,000, or about 10 per cent more than in 1873. In the number of postal telegraph offices there was, however, no material change, owing in great measure to the fact that —previous to its commencement—the telegraph system had already been extended to all places in the kingdom of considerable size. Although the year has not been signalised by any very important changes in the mode of carrying on

the telegraph service, numerous minor improvements have been effected, which have enabled the Department to afford increased facilities to the public, and in many cases materially to lessen the cost of working. Of these, the principal have been the further application of the system of 'duplex' telegraphy and the more general use of the so-called 'sounder' instrument, a form of apparatus greatly in favour in the United States. With most of the advantages of the old 'Morse' apparatus, the 'sounder' instrument combines those of simplicity and cheapness. On one occasion, when an important debate took place in Parliament, and when, in addition, there was an unusual number of interesting occurrences in different parts of the country, nearly 440,000 words—equal to about 220 columns of *The Times* newspaper—were transmitted from the Central Station in London in a single night. The resources of the Department were heavily taxed; but, the weather having been favourable for telegraphy, no delay of any consequence occurred. There has again been a large increase in the rental from private wires, the sum having risen from about £47,000 to about £53,000, or about 12 per cent. The 'Special Arrangements Branch' of the Telegraph Service has, as usual, been actively employed, the officers of this branch having assisted in the disposal of the work in connection with nearly all the more important public events. As an instance of the large number of telegrams sometimes forwarded from a very small place, it may be mentioned that in connection with a Conference of Wesleyan Methodists held at Camborne, which lasted three weeks, more than £350 was received there for telegrams."

The cable of the Direct United States Cable Company is again open for the transmission of messages. The tariff is three shillings per word.

Telegrams for North America are now received at postal telegraph offices in the United Kingdom, for transmission by either the Anglo-American Telegraph Co. (Limited), *via* Valentia, or by the Direct United States Cable Co. (Lim.), *via* Ballinskelligs.

The Royal Society.—A Royal Medal has been awarded this year to Mr. William Crookes, F.R.S., for his various chemical and physical researches, more especially for his discovery of Thallium, his investigation of its compounds and determination of its atomic weight, and for his discovery of the Repulsion referable to Radiation. The other awards are—The Copley Medal to Prof. A. W. Hofmann, F.R.S., for his numerous contributions to the science of Chemistry, and especially for his researches on the derivatives of Ammonia; A Royal Medal to Dr. Thomas Oldham, F.R.S., for his long and important services in the science of Geology. It is hoped that Dr. Hofmann may be spared from Berlin for a few days, so as to receive the medal in person. The medals will be presented at the Anniversary Meeting of the Society, on the 30th inst.

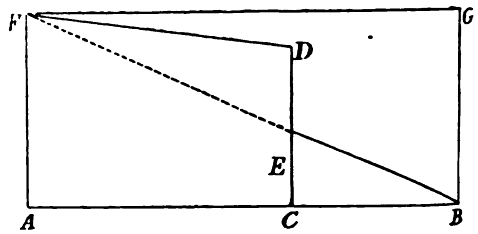
CORRESPONDENCE.

LOCALISING A FAULT OF TOO HIGH COPPER RESISTANCE IN A TELEGRAPH CABLE.

To the Editor of the Electrical News.

Sir,—I send you the following account of a method of localising a fault of too high copper resistance in a telegraph cable, thinking that it may be interesting to some of your readers. It is, I believe, original; at least I have been unable to find any account of a similar test. It was successfully used on a recent occasion when the copper conductor of a cable broke, leaving the *insulation* perfect and the broken ends of the wires slightly touching, thus increasing the resistance of the cable from 2000 to 3000 ohms. In such a case the ordinary discharge test would be useless, as almost the full capacity of the cable would be obtained.

The following formula does not claim to give an *exact* solution of the problem, which is a very complicated one, but only to be an approximation which will give results within the limits of observational error.



Let A B represent the cable, whose normal copper resistance is R ohms, and which has at C a fault of F ohms resistance. Let A C$=x$, $r=$ copper resistance per knot (normal), and $c=$ capacity per knot. Draw A F and C D perpendicular to A B, making—

$$AF : CD :: R+F : R+F-xr.$$

Complete the rectangle A B G F, and join F D and F B meeting C D in E.

1. Let the end B be free, and let A be connected with a battery; then the rectangle A G will represent the total capacity of the cable, and therefore A F$=c$.

2. Let the end B be put to earth, and let A be connected with the battery as before; then the polygon A F D E B will represent the charge in the cable, for the potential at any point is proportional to the resistance from that point to earth. Now, if the resistance of the fault + the resistance of C B be greater than the resistance of A C, and if A be put to earth, the current will practically divide at C, and the part represented by A C D F will flow to earth through A. Let

this be measured and found to be = C. Then—

$$C = \frac{x}{2}(A\,F + C\,D) \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$\frac{A\,F}{C\,D} = \frac{R+F}{R+F-x\,r} \quad \therefore C\,D = A\,F\left(1 - \frac{x\,r}{R+F}\right).$$

Let $\frac{R+F}{r} = Q$ = apparent length of cable from copper test; then—

$$C\,D = A\,F\left(1 - \frac{x}{Q}\right) \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$\therefore$ from (1) and (2)

$$C = \frac{x}{2}\left(2 - \frac{x}{Q}\right)A\,F = \frac{x}{2}\left(2 - \frac{x}{Q}\right)c, \text{ for } A\,F = c,$$

$$\frac{C}{c} = \frac{x}{2}\left(2 - \frac{x}{Q}\right) = M,$$

suppose = apparent length of cable from capacity test.

$$\therefore x^2 - 2\,Q\,x = -2\,Q\,M$$

$$\therefore x = Q \pm \sqrt{Q^2 - 2\,Q\,M}.$$

The − sign must be used for the case of too high resistance; the + sign occurring with a fault of too low resistance—*i.e.*, a fault of insulation.

In making the test great care must be taken to take the discharge the same instant that the battery connection is broken.—I am, &c.,

C. Michie Smith.

13, Blackwood Crescent, Edinburgh,
October 20, 1875.

ELECTRICAL SCIENCE IN FOREIGN JOURNALS.

(This column is devoted to a list of Electrical Memoirs published in Foreign Journals. Those of importance will be either translated in full or given in abstract.)

Comptes Rendus Hebdomadaire des Seances de l'Academie des Sciences.

Vol. lxxxi., No. 14, October 4, 1875.

The Existence of Ferruginous and Magnetic Corpuscles in Atmospheric Dust. By G. Tissandier.

No. 15.

Processes of Magnetisation.—J. M. Gaugain.—A series of arguments based upon previous papers by the author relative to the processes of magnetism.

Formation of Hail.—G. Planté.—Referring to preceding papers on certain phenomena produced in liquids by electric currents of high potential (*vide* Elect. News, pp. 7 and 127) being capable of explaining the origin of waterspouts and polar auroras, M. Planté says—"It seems deducible, from the facts quoted in my previous memoir, that the formation of hail may be attributed to the rapid vaporisation of cloud-water, by the calorific effect of the multiplied flashes which traverse them, and to the rapid congelation of this vapour—when it is produced in the cold regions of the atmosphere, or when, in the encounter of two cloud-masses, one of them has a very low temperature. . . . One can conceive the enormous quantity of heat and steam which a quick flash may produce in the interior of clouds." M. Rozet remarked violent movements—such as the transformation of cirrus into nimbus—in the middle of clouds from which hail fell.

Electric Conductivity of Pyrites.—H. Dufet.—Wheatstone's bridge and mercury contacts were used. The fragment experimented upon was of cubical shape, and had four of its faces covered with sealing-wax: the remaining two faces were cleaned, and in communication with the Wheatstone. "M. Braun says that the resistance of metallic sulphides, and notably of iron pyrites, varies with the direction, strength, and duration of the current, and that this variation may attain one-third of the mean value. I have not in any way verified this with pyrites: the change of current's direction causes no variation in the resistance that the apparatus could determine. . . . As to the influence of current duration it may be remarked, in general, that resistance gradually diminishes, but becomes sensibly constant at the end of a day or two. As regards the effect of heat on conductivity, the pyrites being fixed with plaster-of-paris instead of sealing-wax, it was heated to 100° without any thermo-electric current. Increase of resistance by reason of temperature then became very distinctly manifest; for instance, at 15° a resistance of 0·142 Siemens became at 100° equal to 0·196 Siemens." M. Dufet thinks the conductivity of pyrites is a true metallic conductivity, very variable according to physical structure, but which in a given crystal, depends neither on the direction, strength, nor duration of the current.

No. 16.

Thirteenth Note on the Electro-Conductivity of Bodies of Medium Conducting Power.—Count Th. du Moncel.

Chloride of Silver Battery of 3240 Elements.—MM. Warren de la Rue and H. W. Muller.—These papers will appear in our next issue.

Monatsbericht der Konigl. Preussischen Acad. der Wissenschaften zu Berlin.

January, 1875.

Further Facts towards the Establishing of an Adequate Theory of Electric Machines of the Second Kind.—M. Poggendorff.

February.

Contribution to the Knowledge of Weak Electric Sparks.—M. Riess.—These sparks, which

were described by the author in *Poggendorff's Annalen* (137, 451), differ from the ordinary strong sparks not only in form, light, and sound, but in other and very various properties. From his experiments, M. Riess finds that the greater length of the negative electrode is not an essential condition for producing the weak sparks; that in reference to length, light, and sound they are independent of the composition of the circuit in which they occur; that the discharge of two opposite charged jars, if it takes place with weak sparks, does not cause any marked heating of the circuit or magnetisation by the latter, whereas both actions are readily observed when the weak sparks are changed to strong ones. M. Riess obtained the weak sparks very well with disc condensers.

March.

Nothing on electrical science.

April.

On the Savi Bladder of the Torpedo.—M. Boll. —A histological account.

May.

Influence of Illumination on the Conductivity of Crystalline Selenium.—M. Werner Siemens. —See Elect. News, p. 88.)

PATENTS.

APPLICATIONS FOR LETTERS PATENT.

3600. W. Ladd, of Beak Street, Regent Street, for an invention of "An automatic combined key-switch for use in connection with submarine or other telegraphic wires."—A communication to him from abroad by Andrew Jamieson, telegraphic engineer, of Pernambuco, Brazil.—Dated October 16, 1875.

3666. J. F. Lackersteen, of Southampton Buildings, for an invention of "A new or improved telegraph cable."—Dated October 21, 1875.

NOTICES TO PROCEED.

2132. H. Gardner, of the firm of Robertson, Brooman, and Co., of Fleet Street, London, has given notice in respect of the invention of "An improved frictional electric battery."—A communication to him from abroad by G. M. Mowbray, of North Adams, Mass., U.S.A.

2101. Luis Marie de Bejary O'Lawlor, of Madrid, and Nicholas Antonio Calvo, of London, have given notice in respect of the invention of "Improvements in electric telegraphy."

GRANTS OF PROVISIONAL PROTECTION FOR SIX MONTHS.

3431. To J. A. Morton, of Newcastle-upon-Tyne, for the invention of "A new or improved self-adjusting electric-bell indicator."

3340. To J. C. Fuller and G. Fuller, both of Fenchurch Street, London, for the invention of "A new or improved galvanic battery, applicable to telegraphic and other purposes."

3354. To F. Rooke, of George Street, Stonehouse, Devon, for the invention of "Improvements in intensifying coils and contact-breakers for electric circuits."

3374. To J. Muirhead, jun., of Stanley Villa, Thornton Hill, Wimbledon, Surrey, for the invention of "Improvements in electric telegraphs."

3416. To J. H. Johnson, of Lincoln's Inn Fields, London, for the invention of "Improvements in electro-magnetic engines."—A communication to him from abroad by José Santiago Camacho, of Paris, France.

3466. To W. Prosser, of St. Luke, Chelsea, for the invention of "Improvements in lamps adapted to the electric light, and in the manipulation of the means employed for the supply of the electric fluid thereto."

3509. To R. H. Courtenay, of Meyrick Road, Clapham Junction, for the invention of "An improved thermo-electro-magnetic motor."—Dated October 9, 1875.

PATENTS WHICH HAVE BECOME VOID,

By reason of the Non-payment of the Additional Stamp Duty of £50, before the Expiration of the Third Year from the Date of such Patents.

3016. E. O. W. Whitehouse, of Roslyn Hill House, Hampstead, Middlesex, and S. E. Phillips, of Homerton, in the said county, for an invention of "Improvements in recording apparatus, specially applicable for the verification of fares in public vehicles."—Dated October 12, 1872.

PATENTS GRANTED IN FOREIGN STATES.

United States of America.

167,510. *Galvanic Batteries.* B. F. Dawson, of New York, N.Y. Filed July 24, 1875.—For the purpose of keeping fresh fluid in contact with the plates, and preventing the collection of *effete* matter. *Claim.*—The combination of the perforated positive plate A, negative plate B, and agitating device arranged between the same, substantially as described, whereby, when the agitator is operated, it will act to draw the fluid through and force it out of the perforations in the positive plate, as and for the purpose specified.

167,685. *Electro-Magnetic Telegraphs.* J. Olmsted, of Providence, R.I., assignor of one-half of his right to C. G. McKnight and G. Chatterton, of the same place. Filed May 15, 1875.—*Claim.* The combination, with a telegraph line, of a commutator, charging the line with alternating currents, a pair or series of pairs of keys, and a pair or series of pairs of relays, one of the keys of a pair acting to cut off from the line the + currents only, the other to cut off the − currents, and one relay of each pair being arranged so as to vibrate by the passage therethrough of + currents, and the other by the − currents, and both relays arranged to give a signal or close a local circuit upon the cutting off from the line of the currents affecting it, substantially as and for the purposes described.

*** Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which "The Electrical News and Telegraphic Reporter" is the organ, will always command attention. Literary communications and books for review should be addressed to the Editor; business communications to the Publisher, Boy Court, Ludgate Hill, London, E.C.

THE ELECTRICAL NEWS

AND

TELEGRAPHIC REPORTER.

A FORTNIGHTLY JOURNAL DEVOTED TO EVERY BRANCH OF ELECTRICAL SCIENCE.

Edited by WILLIAM CROOKES, F.R.S., &c.

PUBLISHED ON THE 1st and 15th of EACH MONTH.
Price 3d.

Annual Subscription, post-free, Seven Shillings.

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LONDON: BOY COURT, LUDGATE HILL, E.C.

London Printed and Published by the Proprietor, William Crookes, at the Office, Boy Court, Ludgate Hill, E.C. November 15, 1875.

THE

ELECTRICAL NEWS

AND

Edited by Wm. Crookes, F.R.S., &c.] **TELEGRAPHIC REPORTER.** [Registered for Transmission Abroad.

Vol. 1.—No. 19.] December 1, 1875. [Price, 3d. Post Free, 3½d.

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THE ELECTRICAL NEWS.

Vol. I. No. 19.

FURTHER NOTE ON THE ELECTRIC CONDUCTIVITY OF MINERAL SUBSTANCES.*

By the Count TH. DU MONCEL.

(Continued from page 178.)

Before discussing my researches on this subject, respecting damp substances, I must mention that experiments show the inversion of the polarisation current (set up on rapidly electrifying a dielectric which has previously experienced an inverse electrification) *is not only reproduced in silica and some metallic minerals, but even in all moist bodies (living or inanimate) and also in the generality of liquids.*

Struck with the abnormal effects produced when I repeated my experiments on hard stones, I more closely analysed the phenomenon by first examining whether the polarisation currents—so energetic and continuous in the Héronville silica—would be produced by reversing the position of the stones between the electrodes, or even by placing them between fresh plates. To my astonishment it was evident that *the electrodes do not*, in these polarisation effects, *play the simple part of conductor, but that they acquire (under the electrifying influence) a peculiar electrical condition which may be retained for whole days, and which is dispersed by the action of intense heat.* This electrical condition could not, however, of itself determine a polarisation current: *to that end the dielectric must have undergone electrification under the influences of its own electrodes.*

With an unelectrified dielectric no sensible current is produced; but, once let the electrodes and the dielectric be simultaneously electrified, *they may then be separated for a long time, and the current will reappear on again being united.*

If, after the dielectric has been electrified, new plates replace the old electrodes, a weak current only is produced, and its importance depends on the polarisation-energy of the dielectric. Should it have been electrified for a few moments only, new electrodes will generally transmit no current; but if electrification has been prolonged the current may become tolerably strong, without, however, acquiring the force the original electrodes would have given.

In order to study what takes place in the interior of the dielectrics under the influence of electrification, I formed my dielectric of sheets of paper placed one upon the other, and damped with distilled water,—taking care to well wipe them after moistening them,—and placing them between two plates of ebonite (the upper one being loaded with a leaden weight), the current was sent through them by means of two electrodes introduced between the sheets and the insulating plates. Similar experiments to those undertaken with hard stones were made; and I could—after having ascertained the polarisation then determined—successively take away the sheets, and assure myself of their polarisation condition.

From these experiments it appeared that *the sheets were quite polarised and capable of furnishing an energetic polarisation current of same direction; but it was difficult to form an opinion of the importance of this current on account of the decreased resistance when each sheet was taken away.* Once carried away these sheets preserved their electric condition, but it was necessary to make use of the same electrodes that had electrified them to obtain a polarisation current.

(To be continued.)

* Communicated by the Author.

ON A VERY SENSITIVE DRY-PILE ELECTROSCOPE.

In a recent number of the *Journal de Physique* M. Auguste Righi gives directions how to make a dry pile electroscope of extreme sensibility. The piles, he says, should be rendered movable by means of screws fitted to their base; the lower poles should communicate with the ground by the metallic gas-pipes, and the upper poles carry two broad parallel plates of brass, between which is the gold-leaf. The latter is very short and very narrow. The piles are approximated to the leaf till it is in very unstable equilibrium, and commences, with the least charge, to oscillate between the poles. On putting it then in communication with the ground, at the moment when it is near its position of equilibrium, it is possible to maintain it there. The communications with the ground and those of the conductors with the gold-leaf should be made by soldering, or at least amalgamation.

The apparatus does not give false indications, and its sensibility becomes so great that it is easy to repeat the experiment of the double zinc-copper plate, even without a condenser. The author soldered to the stud of the instrument four metallic wires—platinum, copper, iron, and zinc. When the gold-leaf is at first vertical, it moves whenever one touches the zinc or the iron wire, or even the copper. If one touches the zinc, then the iron, then the copper, and, lastly, the platinum, there is ob-

served at first a great deflection, which diminishes at each new contact. The same effects are obtained if, instead of touching the wires with the fingers, they are plunged into a glass of water, insulated or not. In delicate experiments the metals evidently must not be touched with the fingers. For lecture experiments the author projects a very large image of the gold-leaf, with the Drummond light. The instrument is very convenient and easily managed.

With this instrument the author repeated experiments on electricity of contact, described in the *Journal de Physique* (t. iii., p. 19), and with the same results: in particular he observed that the charges between a disc of copper and one of zinc do not sensibly depend on the insulating medium in which the zinc is. The experiment still succeeds when the metal is covered over with a layer of gum-lac several millimetres in thickness. Between two discs of the same metal, but one of them covered with resin, no appreciable effect is obtained provided the discs have a well-cleaned surface.

M. Righi has also observed that on contact of two discs of the same nature, at different temperatures, there is a difference of potential; for all the metals and other conductors examined, the cold disc takes the positive electricity. This does not agree with the experiments of Sir W. Thomson and M. le Roux, on the thermal effects produced by a current which passes between two parts of the same metal at different temperatures: these effects are said to be in contrary direction in certain metals; in particular, iron and copper behave in two opposite ways. M. Righi has repeated the experiments with iron and copper. Each disc has an insulator of glass, and forms the bottom of a cylindrical case, which may be filled with water either at 100° or at zero. The two discs of copper are taken and raised to nearly 100°. It is found that on putting them in contact they do not show a charge when brought to the electroscope. Then cold water is substituted for the hot which heated one of the discs, and it is observed that the cold disc is charged with positive electricity, the warm disc with negative. The signs of electricity disappear on cooling the other disc, or heating the first anew.

If the two discs, being at the same temperature, give small charges, which is frequently the case with iron discs, one may clean the discs, or cool that one which takes negative electricity; one then obtains an inversion of the electric signs.

"Iron and copper, then, behave in the same manner, and not in an opposite manner. This difference between the electrostatic and the electrothermic experiments is also observed when one studies the electromotive forces of contact."

MAGNETO-INDUCTION MACHINES (HEFNER-ALTENECK SYSTEM).

The action of these machines — of which Siemens and Halske, of Berlin, and Siemens Bros., of London, have of late made several, of various sizes, for electrical lighting purposes— is based on the fact that in a closed conductor an electric current is induced if a part of the conductor is made to pass between two contrary magnetic poles placed opposite each other: the direction of the induced current depends on the position of the poles relatively to the direction of motion. The magnetic poles may either be those of a permanent steel magnet or of an electro-magnet; in the latter case, according to the electrodynamic principle, the current furnished by the machine may itself be employed in strengthening the remanent magnetism of the electro-magnet. Messrs. Siemens make both kinds.

The machine here described is a *single* apparatus, in which the core of the armature is *fixed*, and the wire-helix alone caused to rotate. By fixation of the armature-core great inductive power is obtained, and consequently powerful currents. With about 380 revolutions per minute of the wire-helix, and 9 to 10 horse-power, a light equal to 14,000 candles is obtained. Water is not required to cool the apparatus.

In this machine (shown in elevation, Fig. 1; in section, Fig. 2) the conductor, by the motion of which the electrical current is produced, is of insulated copper wire, coiled in several lengths and many convolutions upon a cylinder of thin German silver, in such a manner that each single convolution describes the longitudinal section of the cylinder. The whole surface of the metal cylinder is thus covered with wires, forming also a cylinder closed on all sides (*a*, *b*, *c*, *d*, Fig. 2).

This hollow cylinder of wire encloses the stationary core of soft iron (n, s, s^1, n^1, Fig. 2). This hollow iron core is made stationary inside the cylinder of wires by means of an iron bar in the direction of its axis, prolonged at both ends through the bearings of the wire cylinder to standards.

Surrounding the wire cylinder for about two-thirds of its surface are the curved iron bars (N, N^1, S, S^1, Fig. 1 and Fig. 2), the space between these curved bars and the stationary iron core being nowhere greater than is necessary to permit the free rotation of the wire cylinder. The curved bars are themselves prolongations of the cores of the electro-magnets (E E, E E); the sides of these two horse-shoe magnets (N, o—S, m and N^1, o^1—S^1, m^1) are connected by the iron of the two standards (o, m, and o^1, m^1).

The coils of the electro-magnets form an electrical circuit with the wires of the revolving

cylinder, and upon revolution of the latter a powerful current passes into the electro-magnetic coils, again exciting a still more powerful current in the wires of the cylindrical armature. The iron core of the cylindrical armature being very little distant from the poles of the electro-magnets, in proportion to the extent of opposed iron surface, becomes itself an intensely powerful transverse magnet of opposite polarity to the electro-magnet: the cylinder of wires thus revolves in a field of highest magnetic intensity.

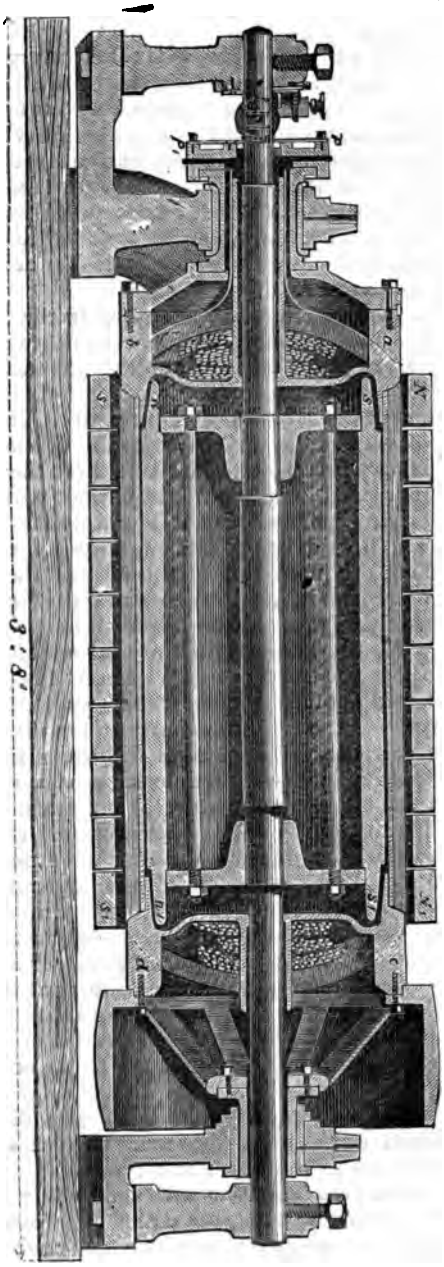


Fig. 2.

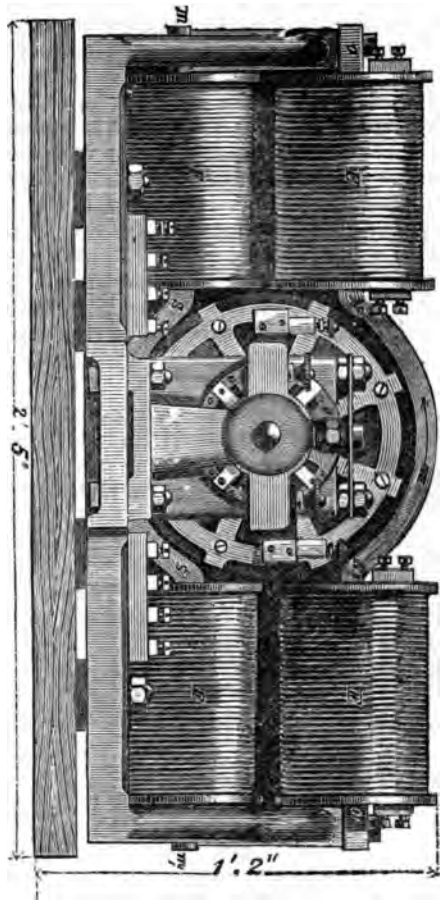


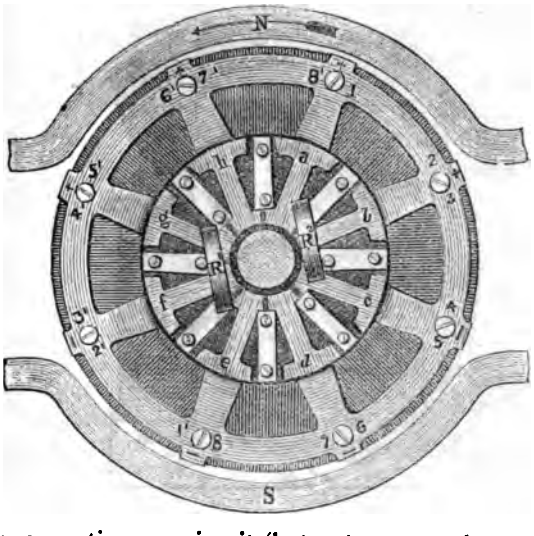
Fig. 1.

At each revolution of the wire cylinder, the maximum impulse in each convolution will be attained when passing through the middle of both magnetic fields, and will descend to zero when arriving vertical to that position. At this latter position will be a neutral line; and, according to the electro-dynamic law laid down by Lenz, a convolution starting from that line towards the north pole of the electro-magnet would be subject to a direct induced current; the opposite wire (continuing the convolution on the other side of cylinder) will be traversed

by a current of opposite direction—that is, opposite with regard to right- and left-handed directions, but of a same direction as regards circuit, the opposite wire being subject to magnetic induction of an opposite polarity. This action will take place with all convolutions, so that the currents caused to circulate in each are of the same direction as regards circuit, but opposite in mere direction, at opposite portions of the convolution. As the currents are collected by the terminal rollers, or brushes (presently to be described), they present in the two halves of the cylinder, as separated by the magnetic neutral line, analogous poles to those of two batteries, supposing the two batteries to be connected in parallel circuit, to give a current of quantity.

The circumference of the cylinder is divided into eight equal parts. Two such opposite parts are coiled one over the other, with *two* equal lengths of wire; the four ends of these wires being brought to the front end (*a*, *b*, Fig. 2) of the cylinder, and connected to the eight metal sector springs ($p\,p'$) of the commutator, these springs being electrically separated by strips of ivory, as shown in Fig. 3. The several segments of coils of wire, however, form

Fig. 3.



one continuous circuit (but not one continuous helix), being connected electrically at the sector springs, as may be seen by tracing out the connections, which show the following circuit:— $+1 . f . +4' . -4 . g . +6' . -6 . h . +8' . -8 . a . +2 . -2' . b . +3 . -3' . c . -5 . +5' . d . -7 . +7' . e . -1' . +1$. The ends of the same length of wire are respectively numbered 1 and 1', 2 and 2', &c., and the signs + and − show the polarity of the electrical impulses of each wire (regarded by itself) as they arise, according to the momentary relative position, supposing the wire cylinder to be rotating in the direction of the arrow.

These electrical impulses are collected upon two metal rollers, or brushes, so that at two points diametrically opposite the single sectors pass under the rollers, or brushes, with elastic pressure, yielding up to the latter their electrical charge.

It will be seen, when following the course offered to the current with the connections described, that all electrical impulses of the several helices will transfer to a sector arriving at + positive electricity, and to a sector arriving at − negative electricity; and that here the rollers to which the terminals of the instrument are connected must be applied to collect the electric current, which will be constant and continuous.

A slight increase of speed in the rotation of the wire cylinder effects a considerable increase of current. As the current increases so does the resistance to rotation increase, and renders necessary a higher driving power. This increase is very rapid. With increase of current there is also increased heat; and were it not for this increased heat one might obtain, with sufficient driving power, almost any amount of current. The heat developed at high speeds would overheat the insulation of the wire of the machine; therefore in continuous work the speed of the machine must not be taken too high.

As the strength of the current also depends upon the exterior resistance (line, &c.) the speed should be slower, the smaller that resistance or the total resistance in circuit. With an electric lamp in a circuit of little resistance the wire cylinder—if the machine is intended to work continuously—should not make more than 370 to 380 revolutions per minute. The heating of the machine will then attain a maximum in about three hours, and will, during working, remain constant at that temperature. The driving power at that speed is about 8 indicated horse-power (75 kilogrammetres per second).

The intensity of the naked light at this speed, the light being unaided by any reflector or lens, and as tested by a Bunsen photometer, has repeatedly been found equal to 14,000 normal (English) candles. This is believed to be the maximum intensity obtainable with the electric light, as a more powerful current splits and breaks up even the best carbons.

From the fact that a closed circuit revolving or rotating in a magnetic field experiences great resistance to its rotation, to which an interrupted or non-continuous circuit is not liable, motive power to any extent is required only when the machine produces a current, *i.e.*, when the circuit is closed. An interruption to the circuit, therefore, is equivalent to taking off the load from the driving engine, which, for purely me-

alloy for use in thermopiles. The thermo-electric power of a metal or alloy appears to be quite unconnected with its power for conducting heat or electricity, or with its voltaic relation to other metals; neither does it appear to have any relation to specific gravities or atomic weights. The thermopiles employed were of a form slightly modified from that employed by Pouillet in his demonstration of Ohm's law. Alloys are frequently more powerful than elementary metals; thus, 2 parts of antimony and 1 part of zinc have a negative power represented by 22·70, while that of antimony is 6·96 or 9·43, and that of zinc is 0·2. A strange exception, however, is that of bismuth and tin; for, while the power of pure bismuth is +35·8, when the two metals are alloyed in the proportion of 12 to 1, the power becomes −13·67. Dr. Stone first used a couple consisting of iron and rich German silver (that is, rich in nickel). This was characterised by great steadiness, but the electromotive force produced by moderate differences of temperature was not great. He then used Marcus's negative alloy, consisting of 12 parts of antimony, 5 of zinc, and 1 of bismuth, but the crystalline nature and consequent brittleness of this mixture were found to be great objections to its practical use. It occurred to Dr. Stone that the addition of arsenic might diminish the brittleness without injuring the thermo-electric power; and, on trial, it was found that an alloy of zinc, antimony, and arsenic, with a little tin, formed a much less brittle mass than Marcus metal, with quite as great, or greater, thermo-electric power. A set of twelve couples of this alloy and German silver was exhibited. The electromotive forces of this set, and of a similar one of 12 iron and German silver couples, were determined by Mr. W. J. Wilson, and found to be, for one alloy and German silver couple, with difference of temperature of 80° C., 1-108th of a Daniell's cell. The electromotive force of one couple of the iron and German silver set was 1-648th of a Daniell's cell. The ordinary method of applying heat by a trough of hot water is objectionable, for the water short-circuits some of the current: this is evident from the fact that, if oil heated to the same temperature be substituted, a considerably greater deflection is obtained. Another method suggested by the author, which would tend to economy, is to allow petroleum to volatilise in the neighbourhood of one face of the pile, thus chilling it, and to ignite the mixture of air and gas so produced at the other face. Clamond's pile, consisting of iron and an alloy of zinc and antimony, was employed for some time, but, although good results were obtained, the iron is liable to rust at the connections.

Dr. Guthrie remarked that, in researches of this nature, the main object in view was to ascertain what relation, if any, existed between the direction of the current and the amount of heat flow. He referred to the experiment with a tangle of fine platinum wire, by which it is found that, if either end of the wire be heated, a current flows towards the tangle, and this takes place however well the tangle may be annealed. He suggested that the great effect which alloying one metal slightly with another has on its position in the thermo-electric series may, perhaps, be connected with its change in conducting power for heat.

Mr. Walenn referred to experiments which he made some years since on thermopiles when used at high temperatures. The most powerful currents were obtained with a couple in which amalgamated copper was employed, but the power was soon lost, in consequence of the volatilisation of the mercury. Subsequently he employed wires of wrought-iron and German silver, and, although the results were not specially remarkable at moderately high temperatures, the power became great when the connections were raised to a red-heat.

Prof. Foster called attention to Matthiessen's "Table of the Electric Conductivities of Metals and Alloys," in relation to the use of the latter in thermopiles. The fact shown by Matthiessen, that the conductivities of alloys are greatly influenced by changes of temperature, will probably, he considers, be found to have some connection with their thermo-electric action. He also mentioned, as a fact which should be remembered when considering the construction of thermopiles, that the presence of minute traces of impurity completely changes the electric conductivity of a metal.

INSTITUTION OF CIVIL ENGINEERS.

At the second meeting of the Session, held on Tuesday evening, the 16th of November, Mr. George Robert Stephenson, Vice-President, in the chair, the paper read was "On the Pneumatic Transmission of Telegrams," by Mr. R. S. Culley, M. Inst. C.E., and Mr. R. Sabine, Assoc. Inst. C.E.

The paper commenced with a short sketch of the history of the process, and gave a statement of the extent to which it had now attained. There were twenty-four pneumatic tubes in London, of an aggregate length of 17 miles 1160 yards, four tubes in Liverpool, three in Dublin, five in Manchester, three in Birmingham, and one in Glasgow. The London system was described. When the number of tubes became large it was found necessary to simplify the valves and sluices, rendering them less automatic, but easier to keep in order, than the earlier apparatus. Lead was preferred to iron as the material for the tubes. An experience of

twenty-one years had shown that with felt message-holders, or carriers, there was no abrasion of the metal, which became highly polished, and that the tubes were practically air-tight, the exhaustion in one, 1289 yards in length, occupying thirteen minutes in falling from 17·25 ins. of mercury to atmospheric pressure, including the leakage from the valves. Iron had been used for two tubes, each 2610 yards long, but it was found to rust rapidly and to wear out the carriers. In the Paris system the iron tubes did not rust, and it was suggested that the difference was due to the air in Paris being carefully cooled by water, and to the friction of the heavy carriers of iron covered with leather; while the air in London was used warm from the pumps, and the carriers were made as light as possible. The diameter adopted for the tubes was 2¼ inches, as being large enough to carry the traffic with sufficient speed, and not so large as to require a costly volume of air. The process of laying and jointing the tubes was explained. The carriers were cylindrical boxes of gutta-percha, covered with shrunk drugget; their weight was 2¾ ozs. The traffic was regulated by electric signals. Stoppages were rare, and were cleared by filling the tubes with water and applying pressure. It had never been necessary to open a lead tube, except in cases of bad construction or of external injury caused by workmen. The engines were on the Wolff principle, and in ordinary work expended 134 indicated horse-power. The pumps were so arranged that each could be set to compress or exhaust at pleasure, and the air-valves were fixed in sliding pieces, so that a defective valve could be quickly replaced.

The paper went on to show why a much more costly system of tubes and much larger engines were requred in this country than in Paris, Berlin, or Vienna, where the pneumatic system was also in operation. On the Continent, with perhaps an exception as regarded the Paris Bourse, trains of carriers were run at fixed times, in Paris every quarter of an hour; but in England a message was never delayed—speed was the first requisite, and carriers followed one another as rapidly as possible. The tubes could not therefore, as a rule, serve more than a single station; stations could not be grouped in circles; but each tube had to be direct, and as short as possible. An opinion expressed during a former discussion of the subject, that pneumatic was more costly than electric transmission, was shown to be erroneous; for the total expense of the former in London was barely two-thirds of the amount which would have been required to pay the salaries alone of the clerks needed under the latter, irrespective of the cost of wires and instruments.

Theoretical principles were next discussed. Formulæ were given for the mechanical effect performed by air in expanding, for the volume of denser air which entered the tube during the transit of a carrier, for the speed of carriers, for the times of transit, for the mean weight of a cubic foot of air both for pressure and for vacuum working, and for the work done in compressing and exhausting the air. The results of experiments followed. First special experiments on a tube 5523 feet long, having an intermediate station; then on another tube 4227 feet long, showing the close coincidence of the actual times of transit under various pressures, with the times calculated by the formulæ previously given. The experiments showed also that the speed of a carrier driven by compressed air was greater when the pressure was cut off after each transit; or, in other words, that there was a loss of speed when the air was kept constantly in motion. In the former case the carrier started into a comparative vacuum at atmospheric pressure; in the latter case, into dense air; consequently the higher the pressure employed the greater the difference in speed—with 14 lbs. pressure the difference was 6 per cent. In working by vacuum a reverse result obtained. The experiments likewise demonstrated that the pressure fell to zero at the distant end, and almost regularly with the length, but not quite so. With an initial pressure equal to 18 ins. of mercury the pressure at the end of a tube 8454 feet long was 9·75 ins. instead of 9 ins., and in every case there had been a higher pressure at intermediate points than that due to their position, when the fall of pressure was represented by a straight line. This result was attributed partly to the inertia of the air, partly to friction. The experiments also showed that when compressed air was admitted into a long tube, or the air was pumped out of it, a sensible time elapsed before the permanent condition of the air-pressure was established. In a tube 5523 ft. long this interval was forty-five seconds for the end next the air-pump, and about seventy-five seconds for the centre of the tube. The temperature of the air issuing from a tube was not lowered to an extent corresponding with its expansion in the tube, because it gained heat from the soil in London; but in Berlin, where the tubes were bedded in dry sand, the theoretical temperature was more nearly attained. Comparing a 3 in. tube with a 2¼ in. it was shown that more than double-engine power gave only 16 per cent higher speed in the larger tube, so that any increase of diameter above that actually necessary to carry the traffic in the required time was attended with unnecessary expenditure. Again, by doubling the pressure only 30 per cent in time was saved, but thrice the engine power was needed. In

two tubes, each 1000 yards long, one 3 ins. and the other 2¼ ins. in diameter, by working the larger with a pressure of 5 lbs. and the smaller with one of 7 lbs. the transit was made in nearly equal times, while the engine powers were 2·6 horse-power and 2·1 horse-power respectively. The smaller tube at the higher pressure was therefore the most economical. The tubes should in consequence be as small as possible. The relative economy of working by vacuum, or by pressure, was then considered, to determine at which end of a tube, required for traffic in one direction only, the engine should be placed. It would at first sight appear that vacuum would be less expensive, because there was less weight of air to move than when using pressure. But as the rarefied air gained heat from the tube as it passed along, the volume which must be removed by the pump was greater than it would otherwise be; so that practically the cost of the two systems was the same. Then followed tables for the solution of the various economical questions connected with the system, and practical rules for their use, framed with the object of enabling those who wished to arrange systems of transmission to calculate the pressures, times, and power required.

NOTES.

Mr. T. T. P. Bruce Warren has introduced a new form of patented insulated wire, for general telegraphic purposes, which, having been found to be electrically durable and permanent, is suited for use in situations where liable alternately to exposure to air and submergence in water. Three lengths which were made in February, 1871, have been shipped to Brazil and carried dry for nearly ten months on board ship, through the West Indies and the tropics, and on their return, when again tested (November, 1875), after being kept in water for several weeks, were electrically and mechanically as good as when manufactured. These cores consisted of a strand of seven wires, weighing 107 lbs. per nautical mile, insulated with about 30 lbs. india-rubber, and a single wire, weighing about 50 lbs., with 25 lbs. india-rubber—both without any mechanical protection whatever. A pressure of 600 lbs. per square inch, maintained for twenty-four hours, has been found to produce no effect whatever on this wire, which fact, combined with its high insulation and freedom from mechanical or chemical changes, even in thin coatings, points to its suitability for submarine telegraphs. The insulation resistance of these wires is about 3000 millions B. A. units at 75° (first minute's electrification). Its specific inductive capacity shows that 100 lbs. is equal to 400 lbs. of ordinary gutta-percha, approximately, and about 250 lbs. of vulcanised india-rubber.

At a meeting of the Physical Society, on Saturday last, Professor Guthrie exhibited the arrangement of apparatus employed by Dr. Kerr in his recent researches (see Elect. News, vol. i., p. 214). He also showed certain experiments connected with the investigation.

In a recent number of *Les Mondes* the Abbé Moigno directs attention to hygienic application of electricity. From his remarks it would appear that Dr. Poggioli has devised a system of "electrical gymnastics." The exact nature of these "gymnastics" is not stated, but it is mentioned that recent trials, in the presence of a Committee appointed by the Prefect of the Seine, upon twenty-one school children of known physical weakness and mental debility, resulted in improved respiration and appetite, as well as in improved mental conceptions and an increase in height, weight, and chest-measurement. These beneficial effects are said to have remained three months after the conclusion of the course. *Les Mondes* also states that the same Dr. Poggioli has succeeded in proving that electricity may be usefully employed as a sedative, in nervous affections and certain acute forms of disease.

At the instance of Admiral Likhatchoff, the *Revue Industrielle* mentions that the electric light produced by Gramme's magneto-electric machine has been introduced on the Imperial Russian yacht *Livatia*. Another of the latter, to which a reflector of pceuliar construction is attached, is being prepared by the Paris firm of Messrs. Sautter, Lemmonier, and Co., for the new Russian ironclad called *Peter the Great.*

ELECTRICAL SCIENCE IN FOREIGN JOURNALS.

(This column is devoted to a list of Electrical Memoirs published in Foreign Journals. Those of importance will be either translated in full or given in abstract.)

Comptes Rendus Hebdomadaire des Seances de l'Academie des Sciences.

Vol. lxxxi., No. 17, October 26, 1875.

Magnetic Observations made at the Isle Saint Paul in November and December, 1874.—A. Cazin.—The volcanic rocks composing the foundation of this isle are ferruginous. Those on the north side of the crater, and which result from the slips whereby all the *east* side of the mountain is laid bare, attract the two poles of a magnet, and contain 6 per cent of iron. Those met with around the cones of scoria situated at the foot of the exterior slopes of the crater, on the sea shore, are true magnets with

two poles, containing 14 per cent of iron. The observations made for *declination* and *inclination* indicate the local action of a *south* pole towards the centre of the crater, a fact which should warn navigators to guard against the magnetic influence of this isle.

New Spectro-Electric Tube (Modified Detonator).—B. Delachanal and A. Mermet.—This is eminently practical, since it realises the following advantages :—(1.) Fixity of the spark admitting the prolonged observation of the spectra. (2.) Suppression of the meniscus, and consequently of the absorptions which it procuces by partly hiding the spark. (3.) Electrodes enclosed in a special tube which preserves the instrument from corrosive projections. (4.) Possibility of collecting wholly the substance examined. (5.) The possibility of constituting a group of spectroscopic tubes enclosing, each immovably, solutions of various bodies, and permitting rapid demonstrations and comparisons. In description it is a tube 11 c.m. high and 1·5 c.m. in diameter. A lower platinum electrode passes through the bottom of the apparatus, which is of glass, and rounded similar to a test-tube. The upper portion is closed with a cork, through which a capillary tube passes: the capillary tube is traversed by a platinum wire which nearly meets the lower electrode. The important portion of the apparatus is the small capillary tube. To use it :—Into the large tube the solution to be examined is poured, taking care not to touch either electrode—the lower one as well as the upper being cased in a capillary tube. The liquid is poured nearly level with the top of the lower electrode. Capillary force determines its ascension to the top, upon which an immovable drop is formed, and which becomes illuminated when an induction-current is on. Observation may thus continue indefinitely, so as to admit drawing the spectra.

On Nebulous Spirals.—G. Planté.—A theoretical paper on the physical constitution of heavenly bodies, deduced from the observation of electrical phenomena.

Note on the Observed Relations, at Trevaudrum, between the Results of Magnetic Observations and the Period of Solar Spots.—A. Broun.

Bulletino Telegrafico. Anno xi., August, 1875.

Galvanic Deposition upon Porcelain.—The following process has been recently invented in France, by M. Hansen, for depositing metallic coatings upon substances which are poor conductors of electricity :—Sulphur is dissolved in oil of lavender and evaporated to a syrup; chloride of gold or of platinum is also dissolved in ether. The two solutions are mixed and slightly heated. They are finally evaporated to the consistence of ordinary oil-paint, and applied with a pencil to those parts of the glass or porcelain upon which it is desired to deposit the metal by the battery.

September.

The principal articles in this issue are—a translation of the inaugural speech of Mr. Latimer Clark, as President of the Society of Telegraphic Engineers; a survey of the progress of submarine telegraphy; and a paper giving an account of an electric whistle for locomotives, the invention of MM. Lartigue and Forest, and now in use on the Northern of France, between Paris and Amiens and from Creil to Tergnier.

Carl's Repertorium fur Experimental Physik. Band xi., Heft 4.

Theory of the Galvanometer.—M. H. Weber.—In this first portion of his paper the author first considers the case of a galvanometer with any current curve. To have its maximum sensibility, its resistance must be to that of the rest of the circuit as the diameter of the wire uncovered with silk to that of the covered wire. He also studies mathematically the case of galvanometers with circular current-curve, the wire covering being neglected; and galvanometers with close enclosure of the needle; and gives some applications of the formulæ obtained.

Magnetic Observations in Prague in 1873.

Apparatus for Perforating Glass with the Electric Spark.—MM. Terquem and Trunnin.—This consists of two movable parts. In the upper, a vertical brass rod, with ball above, point below, is enclosed in two concentric glass tubes, the small intervals being filled with colophonium. The brass point reaches through to the lower side of a horizontal glass plate attached to the tubes. In the lower part of the apparatus a right-angled brass rod is fixed, also in colophonium within a glass tube, its vertical part passing up the middle, and terminating in a point on the upper side of a horizontal glass plate resting on the tube. The tube is supported on porcelain and wood. The plate to be perforated is first coated with oil, and put between the two horizontal plates of the apparatus. The metallic points are brought opposite each other, and the outer ends of the rods put in connection with an electric machine or induction-coil.

Les Mondes.
Vol. xxxviii., No. 7, October 14, 1875.

The Copper-Zinc Couple and its Effects.—J. H. Gladstone, Ph.D., F.R.S.—(See ELECT. NEWS, vol. i., pp. 4 and 37.)

No. 8.

Contains nothing suited to our pages.

Journal de Physique. October, 1875.

On the Thomson Electrometers.—M. Alfred Angot.—The author takes the quadrant electrometer and the new absolute electrometer as types of the two categories of instruments Sir W. Thomson has devised for measuring static electricity, and he describes—clearly and with some detail—the latter instrument.

On the Charge of the Insulating Layer of a Condenser.—M. Neyreneuf.—With plates of glass and caoutchouc, whatever the time of charge, M. Neyreneuf gets the following results:—(1.) With a single plate the electrification is inverse on the two faces, positive on the side of the positive armature, negative on the other side. (2.) With a composite plate the electrification is the same, for the two extreme plates, as in the case of a single plate. The *persistent* electrification of the intermediate plates is also the same; but at the moment of their separation, and by simple approach of the electroscope originally charged, the plates may appear positive and negative on their two faces. This temporary effect disappears rapidly when the plate experimented with is held some time in the air. (3.) The position of the plates, temporarily positive or negative, is not at all in relation with their nearness to such and such an armature. As regards plates of mica, he finds that certain plates do not appreciably change when the charge has acted a long time, while they give distinct effects with a continued less charge. When the persistent effect is obtained with a plate held in the air, if it be placed with its negative face on a plane surface, either insulating or not, it adheres to it, and on being removed presents a temporary negative electrification. If the experiment be repeated with the positive face, the temporary electrification is positive. Making the Lichtenberg figures on the plates when strongly charged, he observed (on the parts between the conducting plates) that the two electricities existed simultaneously on each face; the yellow regions, broad and irregular on the positive faces, were separated from the neighbouring red regions by a zone which remained transparent, as if it were in a neutral state. On the negative faces there was a large circular red region, but at the centre a small yellow circle indicating the presence of positive electricity.

Poggendorff's Annalen der Physik und Chemie. No. 9, 1875.

Motions of Electricity in Bodies of Molecular Constitution.—M. Wilhelm Weber.—A theoretical paper, hardly suited for abstraction. The author considers that the movable parts (in all ponderable bodies) whose motion is heat are identical with the parts whose motion is magnetism and galvanism. In one mode of propagation of heat, that in metallic conductors (conduction), the electric particles which are the bearers (*Træger*), of the *vis viva*, themselves pass across the limiting surface between two ponderable elements; in another mode, that in insulators (radiation), they do not. With these coincide two kinds of propagation of electricity, with or without the "bearers."

Further Facts toward establishing an Adequate Theory of Electro-Machines of the Second Kind.—M. Poggendorff.—While still holding, as mainly correct, the theory of those machines which he propounded to the Berlin Academy in 1872, he finds it left out of account many facts requiring to be understood. If one (*a*) of the two discs (which move in opposite directions) be stopped, the other (*b*), when rotated, supplies a current in the same direction as before. If the stopped disc be turned round through 360°, and again held, the result—on rotating *b*—will depend on the direction in which this turning of *a* has been done; if in the direction of its former rotation, the current in *b* is unaltered; if in the opposite direction, it is reversed. And the same holds good for a turning of *a* through 180°, or even 90°. Another class of new phenomena occurred when, after displacing *a* through a certain arc, it was again screwed fast and put in rotation, one way or the other, along with *b*. Here a displacement of 90° had no influence; but if *a* was turned 90° to the left and *b* 90° to the right, and that *simultaneously*, there was a reversal of the current. If *a* were turned round 180° in direction of its original rotation, then back again, the current was reversed. These phenomena, and a number of others (some of them connected with the use of a diametral conductor), M. Poggendorff does not profess to explain. It is evident (he says) that the electricities covering the internal surface of those discs have, on their displacement, a certain influence on each other, through which they undergo another arrangement, being displaced or turned. The case is not explained by induction, and M. Poggendorff inclines to the assumption of polar particles of electricity, which have a determinate position in the discs, and on displacement of these are turned round.

Use of the Electrometer for Determination of Intensity of Current, Polarisation, and Resistance.—M. Fuchs.—He uses Hankel's gold-leaf electrometer, the divergence of the leaves being observed through a microscope. He shows how, with the electrometer, one may ascertain at once the strength of current in chemical measure; also the polarisation of a single electrode while the circuit is closed; and that the greater the resistance to be measured, the more fitted is the electrometer, and the less fitted the galvanometer, for measuring it. The electrometer still has some drawbacks, and M. Fu-

further describes an attempt at greater accuracy by a combination of the electrometric with Poggendorff's compensation method.

The Theory of Influence Machines.—M. Veltmann.

COMMERCIAL NOTES.

The traffic receipts of the West India and Panama Telegraph Company, Limited, amounted in July to £3554, as compared with £2884 in the corresponding period of 1874; and in August to £2992 as compared with £2339 in the corresponding period of 1874.

The traffic receipts of the Brazilian Submarine Telegraph Company, Limited, for the month of October, 1875, were £10,576, against £10,581 for the corresponding period of 1874.

The traffic receipts of the Eastern Extension, Australasia, and China Telegraph Company, for the month of October, 1875, were £19,604, against £16,584 for the corresponding period of 1874.

The Eastern Telegraph Company's traffic receipts for the month of October, 1875, amounted to £35,757, and to £32,853 in the corresponding period of 1874.

The traffic receipts of the Direct Spanish Telegraph Company, Limited, for the month of October, 1875, were £1580, against £1386 in the corresponding period of last year.

The Great Northern Telegraph Company report as follows:—Traffic receipts for the month of October, this year, 387,084 frs.; last year, 420,885 frs. Total traffic receipts, 1st January to 31st October, this year, 3,574,032 frs.; last year, 3,748,925 frs.

The receipts of the Submarine Telegraph Company for the month of October, 1875, were £10,918 1s. 11d.; those for the corresponding month of the preceding year were £9910 14s. 4d.

Creditors of the European and South-American Telegraph Company, Limited, must send particulars of their claims to Mr. F. Whinney, the liquidator, by the 1st of January.

PATENTS.

APPLICATIONS FOR LETTERS PATENT.

3762. T. A. Edison, of Newark, New Jersey, U.S.A., for an invention of "Improvements in autographic printing."—Dated October 29, 1875.

3795. Geminiano Zanni, of Highbury, Middlesex, for the invention of "Improvements in magneto-electric telegraph signalling, indicating, and printing apparatus, applicable for steering vessels, mining, railway, and other purposes.—Dated November 1, 1875.

NOTICES TO PROCEED.

2205. Charles Clamond, civil engineer, of Paris, France, temporarily resident at Lombard Street, London, has given notice in respect of the invention of "Improvements in electro-motor machines, also applicable for the generation of electricity."

2335. Auguste Conod, watch and clock manufacturer, of Lausanne, Switzerland, now of Southampton Buildings, London, has given notice in respect of the invention of "Improvements in electric-clock apparatus, parts ot which are applicable to ordinary clocks."

2351. A. M. Clark, patent agent, of Chancery Lane, Middlesex, has given notice in respect of the invention of "Improvements in telegraphic circuits."—A communication to him from abroad by W. E. Sawyer, of Washington, Columbia, U.S.A.

2395. Henri Adrien Bonneville, patent agent, of the British and Foreign Patent Offices, 18, Rue de la Chaussée d'Antin, Paris, France, and 6, Piccadilly, Middlesex, has given notice in respect of the invention of "Certain improvements in electro-magnetic telegraphs where induced currents are used, and also in apparatus for producing such induced currents."—A communication from Robert Kirk Boyle, electrician, resident in New York, U.S.A.

3382. W. P. Lyon, of Ellington Street, Barnsbury, Middlesex, has given notice in respect of the invention of "Improvements in the means or method of applying magnetism for curative and other purposes."

3416. J. H. Johnson, of Lincoln's Inn Fields, Middlesex, has given notice in respect of the invention of "Improvements in electro-magnetic engines."—A communication to him from abroad by José Santiago Camacho, of Paris, France.

3431. J. A. Morton, electric bell-hanger, of Newcastle-upon-Tyne, has given notice in respect of the invention of "A new or improved self-adjusting electric-bell indicator."

GRANTS OF PROVISIONAL PROTECTION FOR SIX MONTHS.

3600. To William Ladd, philosophical instrument maker, of Beak Street, Regent Street, Middlesex, for the invention of "An automatic combined key-switch for use in connection with submarine or other telegraphic wires."—A communication to him from abroad by Andrew Jamieson, telegraphic engineer, of Pernambuco, Brazil.

PATENTS WHICH HAVE BECOME VOID,

By reason of the Non-payment of the additional Stamp Duty of £50, before the Expiration of the Third Year from the Date of such Patents.

3109. G. B. McKenzie Ross, of Ardgay Cottage, Ross, N.B., for an invention of "Improvements in preserving telegraph poles, the posts of wooden fencing, and other similarly exposed or partly embedded wooden surfaces, and in the means employed therefor."—Dated October 22, 1872.

LETTERS PATENT FOR INVENTIONS WHICH HAVE BECOME VOID,

By reason of the Non-payment of the additional Stamp Duty of £100, before the Expiration of the Seventh Year from the Date of such Patents.

3224. E. O. W. Whitehouse, of Stoke Newington, Middlesex, for an invention of "A new (or improved) mode of protecting insulated telegraph wires."—Dated October 21, 1868.

PATENTS GRANTED IN FOREIGN STATES.

France.

106,645. Leiter, for "A galvanic apparatus."—Dated January 30, 1875.

106,741. Kosloff, for "Electric apparatus for producing fixed and permanent light by dividing the electric current from any source, battery, &c.—Dated February 8, 1875.

106,896. Deschiens, for "Improvements in telegraphic apparatus."—Dated February 22, 1875.

106,914. Siemens and Halske, for "Improvements in using caoutchouc for type."—Dated February 22, 1875.

106,966. Douce, for "Improvements in electric batteries."—Dated February 25, 1875.

Certificates of Addition.

100,997. Camacho, for "Improvements in electro-magnets."—Dated February 6, 1875.

104,673. Guyot d'Arlincourt, for "Improvements in printing telegraphs."—Dated February 1, 1875.

98,045. Siemens and Halske, for "Electro-optical signals for railways.'—Dated February 2, 1875.

101,156. Trouvé, for "A galvanic battery with two liquids."—Dated February 4, 1875.

Belgium.

37,968. J. Laguesse, of Grivegnée-Liége, for "An insulator for telegraph-lines."—Dated October 1, 1875.

37,982. J. Faulkner, for an imported invention of "Improvements in Altendi de Faulkner's electric apparatus."—Dated October 5, 1875.—(French patent, October 4, 1875.)

37,983. A. Billet, a patent of improvement for "An automatic regulator for telegraphic apparatus." —Dated October 5, 1875.—(Original patent, August 16, 1875.)

United States of America.

168,004. *Printing telegraphs.* T. A. Edison, of Newark, N.J., assignor to the Gold and Stock Telegraph Company, of New York, N.Y. Filed June 1, 1874.—*Claim.* (1.) Two electro-magnets in the electric circuit, with an armature moved between their cores in consequence of reversing the polarity of the pulsations, such armature actuating the lever and type-wheel, in combination with the lateral cores of the electro-magnet and the armature that operates the printing-lever, as set forth. (2.) The arrangement of the type-wheel lever and armature between two electro-magnets, and an armature and lever at one side of the type-wheel, operating an impression-pad at the opposite side of type-wheel, substantially as set forth.

168,018. *Magneto-electric machines.* Otto Heikel, of Jersey City, N.J. Filed June 5, 1875.—*Claim.* (1.) The magneto-electric machine, containing helices that are connected together and combined with the circuit-wires, cores, and stationary magnets, arranged substantially as set forth, to produce a continuous circulation of the electric current in one direction, as specified. (2.) The revolving core *a*, contiguous to the stationary magnets, in combination with the helices, arranged in respect to the core, substantially as set forth, to induce a continuous current flowing through the helices, as set forth.

168,143. *Automatic telegraph-keys.* L. S. Crandall, of New York, N.Y. Filed August 21, 1875.—*Claim.* (1.) An automatic telegraph-key, composed of a series of pivoted spring keys or levers, provided with cam or contact pieces of varying shape, corresponding to the Morse character of their letters, in combination with projecting arms of a common transmitting-shaft, spring-pawl, ratchet-wheel, and insulated metal tongue,—the keys, shaft, and ratchet being connected to one pole, the tongue to the other pole, of the battery, to transmit messages by mechanical means, substantially in the manner and for the purpose set forth. (2.) The shaft provided with a series of cam-operated arms D, and a single pawl-arm, having a spring retractor, as and for the purpose set forth. (3.) In automatic telegraph-keys the spring keys, or finger-levers, provided with cam or contact pieces having stem-shaped projections and intermediate extensions for producing the required feed of the ratchet and the dwell at points of contact and non-contact, substantially as specified.

168,144. *Automatic telegraph-keys.* L. S. Crandall, of New York, N.Y. Filed August 21, 1875.—*Claim.* (1.) An automatic telegraph-key for mechanical transmission of messages, constructed of a series of sliding spring-keys representing the letters of the alphabet, and connected, by spring-pawls and ratchet-wheels, with a corresponding number of revolving wheels with partially-insulated circumferences, and with spring tongues or riders in contact therewith, said wheels being connected to one pole, while the tongue is connected to the other pole, substantially as and for the purpose specified. (2.) The combination of two sliding spring-keys, having spring-pawls, with one transmitting-wheel, provided with ratchet-wheels placed in opposite direction to each other, for the purpose of coupling keys having letters with reversed Morse characters, substantially as shown and described.

168,185. *Electric circuit-breaking clockwork.* David Rousseau, of New York, N.Y., assignor, by mesne assignments, to W. F. Smith and S. Samuels, of the same place. Filed August 13, 1875.—*Brief.* The circuit-breaking train of wheels acts only at the time when, in the course of the revolution of a pin-wheel in the time-keeping train, the pins have advanced sufficiently to allow the escape of an arm projecting from a spindle of the circuit-breaking train.—*Claim.* (1.) The arm *a*, combined with the rotary wheel *d* and intermittently-rotating wheel *h*, to constitute a circuit-breaker, substantially as herein shown and described. (2.) The combination of the main-spring B, which rotates the wheel *d*, with the main-spring C, arm *a*, and circuit-breaking wheel *h*, substantially as herein shown and described.

168,242. *Transmitters and receivers for automatic telegraphs.* T. A. Edison, of Newark, N.J., assignor to himself and G. Harrington, of Washington, D.C. Filed January 26, 1875.—*Claim.* (1.) The transmitting-drum *f* and receiving-drum *e* upon the same shaft, in combination with the receiving and transmitting stylus or rollers, *n*, *o*, and a clutch b^1, for connecting either one drum or the other to the shaft *b*, as set forth. (2.) The two contact-rollers *i* and i^1, applied in the transmitting-drum, one at each side of the roller *n* or stylus, in combination with the wire 4, to guide the advancing end of the strip of paper, as set forth. (3.) The roller n^1, removable from the shaft *c*, and revolved by friction, and containing points, in combination with the receiving drum *e* and yielding roller n^2, substantially as set forth.

London Printed and Published by the Proprietor, William Crookes, at the Office, Boy Court, Ludgate Hill, E.C. December 1, 1875.

THE

ELECTRICAL NEWS

AND

TELEGRAPHIC REPORTER.

Edited by Wm. Crookes, F.R.S., &c. | Registered for Transmission Abroad.

Vol. 1.—No. 20.] December 15, 1875. [PRICE, 3d. POST FREE, 3½d.

CONTENTS.

THE ELECTRICAL NEWS.

VOL. I. No. 20.

FURTHER NOTE ON THE ELECTRIC CONDUCTIVITY OF MINERAL SUBSTANCES.*

By the Count TH. DU MONCEL.

(Continued from page 225.)

THE experiments referred to (ELECT. NEWS, vol. i., p. 225) having been repeated with damp substances, and having induced me to face the question in a new light, I again undertook the different experiments by analysing them in their minutest details. The results lead me to slightly modify my first theory regarding the passage of the current through hard stones.

I commenced by examining the effects determined upon different kinds of conductors, by electrodes which had served to electrify the silica, or flint, of which I have already spoken; then I separately studied the effects resulting from the electrification of the flint itself by making use of fresh electrodes of a different nature. In my last note I advanced the statement that the electrodes electrified by the flint in question were not susceptible of determining a current, but that the stone was able to provoke very slight ones, which would speedily become weakened: these conclusions I find must be somewhat modified.

If, after having electrified the flint in question, by means of platinum or copper electrodes, we take the electrified electrodes and place between them an unelectrified stone of exactly the same nature as that which electrified them, *a very energetic polarisation current is set up, which may even develop itself after a rather long lapse of time, if the electrodes remain at rest untouched.* Under these conditions, a very strong heat communicated to the electrodes causes their electromotive power to almost disappear, and, when they are again placed in contact with the stone, no sensible current is produced. It is also the same (and this experiment seems decisive) *if the electrodes, after having been electrified by means of the stone, are united by a metallic conductor or by a stone incapable of furnishing an electrolytic conductivity.* Yet if the *unelectrified* flint is used the current is developed anew, with almost the same strength as though the electrodes had not been submitted to the action of the metallic conductor, &c. It is thus shown that *the current furnished by the electrodes is not the result of an electro-static discharge.*

But upon consideration it appears that, in order for this "electrode-current" to be produced, it is necessary for the electrodes to be united by a conductor of electrolytic conductivity capacity. We may understand how the electromotive force giving rise to this current should evidently result from the electro-chemical polarisation of the electrodes—a polarisation which cannot be accompanied by the creation of a current, unless the condensed gases find in the conductor uniting the electrodes a certain quantity of water. So we can substitute, for the conductors of which we have just spoken, a liquid conductor. With distilled water the effect is almost the same as with the Héronville flint, but the current is more energetic and less durable with ordinary water. On the other hand, since the effect is almost the same with copper plates as with platinum ones, we may conclude that the absorbing property of platinum for hydrogen is not what determines the phenomenon, and that all metals are capable of preserving on their surface or in their pores the gases resulting from the water's decomposition. At one time of my experiments I had in my possession only one single sample cut from my Héronville flint, and I then experimented with a piece of magnetic iron: this gave polarisation effects analogous to those from my Héronville flint, but this mineral—though a good conductor—is not endowed with great electrolytic conductivity, and I was never able by its medium to obtain appreciable currents: for this reason, therefore, did I make the assertion that platinum plates having served as electrodes to a stone could not furnish currents when re-united by a moderately conductible body—a statement which I now correct.

If we study the effects produced by the electrified stone we find the stone has become, like the electrodes, *an electric source furnishing currents more or less energetic and durable, according to the duration of electrification and the nature of the body,* but which with the Héronville flint are always inferior to those induced by the electrodes. It at first seemed difficult to admit that these currents could have a common origin with those provoked by the electrodes; for, during the electrification which determined these two electric sources, the gases due to the water's decomposition should be condensed upon the electrodes. But if we consider that minerals are far from being homogeneous, and that certain portions possibly possess a degree of metallic conductivity which places them in conditions different from those portions which possess more particularly electrolytic conductivity, we are led to believe that the former portions with regard to the others could play the *role* of electrodes, and themselves condense a part of the gases: therefore they ought to produce effects analogous to those from pla-

* Communicated by the Author.

tinum electrodes, and their action should be the more marked as conductivity is the greater; and this is a result experiment proves. Thus when the mineral presents a marked metallic conductivity, as well as an electrolytic conductivity (like magnetic iron) the polarisation currents developed by the stone with new electrodes are infinitely stronger than those from the electrodes separately. These latter currents cannot even reveal themselves when an *unelectrified* stone of similar nature is used for an intermediate conductor, though they may be discovered by the intervention of the Héronville flint. On the contrary, on making the dielectric with a number of sheets of very slightly moistened paper, the sheets—when separated from their electrodes and placed between fresh ones—are only able to liberate a very weak current, and often even none at all. It results from this difference of strength between the currents from the electrified body, and those from electrodes, that—according to the strength of the one or the other—the current obtained by changing the position of the stone with regard to the electrodes varies in direction with the nature of the minerals; and this is, in reality, observed in experiments with the Héronville flint and magnetic iron. With the first the differential current continues in the same direction as that of the electrodes, though rather weakened, whilst the reverse is the case with the second.

Thus minerals, when they are true conductors, have but two kinds of conductivity—electrolytic and metallic; electrotonic conductivity, peculiar to dielectrics, exists only in stones reputed in all respects insulators, and in crystals. Yet, in this new order of ideas, there are still some effects which it will be difficult to explain, one of them being the change of the polarisation current's direction in relation to two inverse electrifications of unequal duration. In what manner, indeed, can we explain how, betwixt two gases condensed on metallic electrodes, that it is the one last disengaged which first manifests its presence, whilst the action of the second is not evident until after the disposal of the other? And it is worthy of remark that this inversion phenomenon is generally connected with all indifferently conducting bodies capable of furnishing energetic polarisation currents. On the other hand, how shall we explain the successive diminution in strength of currents transmitted by flints, when the direction of the current is alternately changed—these alternations, on the contrary, augmenting its strength in damp stones, in consequence of the addition of the polarisation current which results from a preceding inverse electrification? Finally, how explain the still sensible conductivity preserved by flint when it is heated for some time, and experimented upon in a roasted condition?

It is certain there is a particular electrical effect produced exterior to electrolytic action; but numerous experiments are yet necessary in order to determine it with precision. Nevertheless I fully believe electrotonic conductivity and electrostatic polarisation (already referred to) intervene in a more or less marked manner, and it is probably to these causes we ought to assign very feeble, but yet appreciable, polarities met with in slightly moistened homogeneous bodies.

As to the successive increase of the current's strength during its circulation in hard stones, it is not exclusively their property; it is met with, as before shown, when the current traverses very resisting liquids, such as distilled water, which allow only a simple release of gas, This is only a question of resistance and polarisation energy, and the fact that this increase does not exist with ordinary water is its proof. Up to a certain point this effect may be taken account of when considering that with very resisting liquid conductors two diametrically opposite effects are present: the first is the consequence of a very long variable period, in which the strength of the traversing current accumulates, and which naturally involves an increase of this strength with the time; the second is the polarisation effect, which is as much less energetic as the circuit resistance is greater, and which in this case no longer combats with sufficient efficacy the increase of strength due to the other cause, because this latter does not manifest itself. In this respect, with the single hypothesis of electrolytic conductivity, we can thus explain the phenomena produced.

A NEW RELATION BETWEEN ELECTRICITY AND LIGHT.

(Continued from page 214.)

In the December number of the *Philosophical Magazine* Dr. Kerr gives the results of his experiments on "Liquid Dielectrics." The results are summarised as follows:—

Carbon disulphide is birefringent when dielectrified, acting upon transmitted light as glass extended along the lines of force. The electrostatic force and the birefringent power increase together; they also vanish simultaneously, the optical effect disappearing abruptly and totally at the instant of electric discharge (not through the bisulphide). Some irregularities are observed in the experiments when the electric action is intense; but these are certainly due in great part, if not wholly, to the want of even approximate uniformity through any considerable extent of the electric field.

Of the liquids examined there are six which

have given definite and constant results, namely these—carbon disulphide, benzol, paraffin and kerosene oils, oil of turpentine, and olive oil. These bodies are distinctly birefringent when dielectrified, acting upon transmitted light as uniaxal crystals with axes directed along the lines of force, the uniaxal being negative in the case of olive-oil, positive in the other five cases. Dielectrified olive-oil acts in the same way as dielectrified glass, or as glass compressed along the lines of force; the other five liquids dielectrified act as resin dielectrified, or as glass extended along the lines of force. Compared among themselves, with reference to strength of birefringent action, the liquids appear to be very unequal—carbon disulphide the strongest, paraffin and kerosene the weakest. Compared with glass they are much weaker insulators; but if allowance be made for this difference, I think that, for intensity as well as purity of effects, carbon disulphide is far superior to glass. In contrast with glass, all the liquids are characterised by the absence of coercive force and by the rapidity of variation of birefringent action from point to point of the electric field. The birefringent power is sustained in liquids by the present action of electric force at each instant: it seems also to be determined at each point, simply by direction and intensity of force at the point.

The author enunciates the three following assumptions:—

1. The particles of dielectrified bodies tend to arrange themselves in files along the lines of force.
2. Changes of molecular arrangement, consequent upon rise or fall of electric action, are effected slowly and with difficulty in solids, easily and at once in liquids.
3. The lines of electric force, or the axes of molecular files, are lines of compression in one class of dielectrics (glass, &c.), and lines of extension in another class carbon disulphide, &c.).

The facts, when thus interpreted, afford a strong confirmation of Faraday's theory of electrostatic induction; and in whatever way interpreted they give promise of some new insight into that interesting subject, the molecular mechanism of electric action.

The author concludes his paper by expressing the hope that the plate-cell charged in the carbon disulphide will develop from the present rude beginning into a valuable physical instrument, a very delicate optical electrometer.

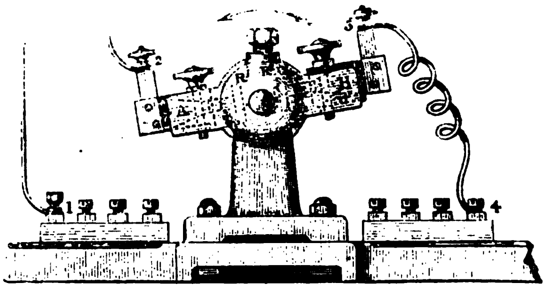
ON the 11th inst. the cable of the Direct United States Cable Company was again broken in the same place where the breakage occurred a few weeks ago.

MAGNETO-INDUCTION MACHINES (HEFNER-ALTENECK SYSTEM).

(Concluded from page 222.)

Rotation from Right to Left, or in the Direction opposite to the Hands of a Watch.—In this case the terminal 4 (Fig. 5) is connected by a wire with terminal 3.

FIG. 5.



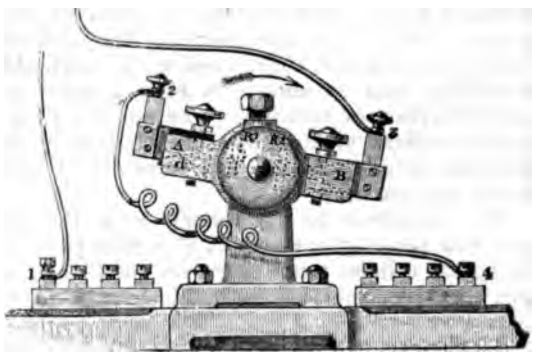
Under the piece of vulcanite (see Figs. 5 and 6), carrying the right-hand roller R^2, is placed a small metal plate *d*, so that the roller R^2 may not be diametrically opposite the roller R^1, but a little higher. The whole movable arm carrying the rollers should stand slightly inclined from the horizontal position, so that its left arm A points slightly downwards, while the right arm B points as much upwards.

The leading wires to the electric lamp are connected to terminate 1 and 2.

Rotation from Left to Right, or in the same Direction as the Hands of a Watch.—Should the direction of a motor pulley, or a given local circumstance, demand motion in a direction opposite to that described, the following alterations are necessary:—

Instead of connecting terminals 4 and 3, the terminals 4 and 2 are to be connected by wire.

FIG. 6.



The small metal plate *d* must be withdrawn from beneath the arm of roller R^1, and placed under the piece of ebonite carrying roller R^1, so that the latter roller may run slightly higher than the right-hand roller R^2. The arm carrying both rollers, which for the purpose is made movable concentric with the axle, must now be

inclined in opposite direction to its former position, so that the right-hand arm B shall stand slightly lower than the left-hand arm A. These ch nges are shown in Fig. 6.

The leading wires to the electric lamp are now to be attached to terminals 1 and 3.

The directions—as right-handed or left-handed—are understood to be taken by a person standing facing the commutator.

Inclination of the roller arm is effected chiefly for the purpose of preventing sparks by reducing the sparking distance to a minimum. In case contact-brushes are used instead of rollers, special care must be taken that the machine be never turned in opposite direction to the arrow marked on the machine, or else the wires of the brushes will get bent and contact spoiled.

The conducting wires from the machine to the lamp should have very little resistance, and should be of copper, of high electrical conductivity. The section should be proportionate to the distance of the lamp from the machine.

If the lengths of the two conducting wires do not together amount to more than 50 metres (say 55 yards), and assuming the copper of high conductivity, a wire of 4 m.m. (=0·157 in.) diameter will suffice. For longer distances it is advisable to use a strand of larger diameter.

The conducting wires must, of course, be in sulated one from the other for the whole length.

Decrease in the strength of the current, caused by the introduction into the circuit of a conductor of too high resistance, may certainly be overcome by increased speed of rotation of the wire cylinder, but only at the expense of increased motive power.

Bright and flying sparks should *never* be allowed to appear at the commutator, as they result from a more or less rapid burning of the metallic parts. The remedy is found in properly inclining the arm carrying the contact rollers (see A and B, Figs. 5 and 6), as previously described, and as shown in Figs. 5 and 6, for each direction of rotation. The position of the contact-rollers yielding the least spark is the position yielding the highest intensity of light in the electric arc.

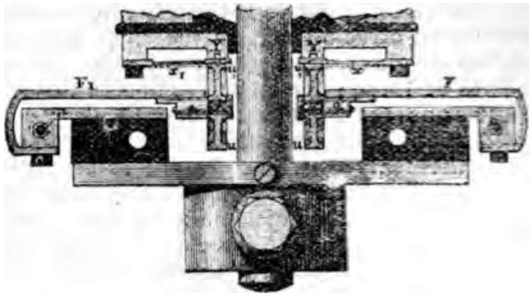
The periphery of the rollers (*u*, *u*, Fig. 7), and the rotating springs (*x*, *x'*) which pass beneath the rollers, must never be oiled, but, on the contrary, kept scrupulously clean from all grease and grit.

Scrupulous cleanliness of all parts of the commutator being of the highest importance, it has been constructed so as easily to be taken to pieces.

The steel pivots (*z*) on which the rollers revolve must, however, be kept carefully oiled, to prevent their heating or sticking. The sticky oil should from time to time be removed, by washing with *paraffin* oil.

The rotating springs (*x*, *x'*) maintain themselves at about ¼ m.m. distance from their metal base (Y), as shown by the dotted line (Fig. 7), being pressed consecutively against the

Fig. 7.



metal base as they pass under the rollers, and the stronger action of the springs (F) to which the rollers are fixed. Adjustment of these springs is important (in order to prevent sparks), but it may be made once for all, as when it may be required to exchange the springs for new ones, or to reverse them.

Should brushes, instead of commutator-rollers, be used, similar precautions have to be taken.

The circuit, when the machine is in action, *should never be suddenly interrupted*. The sudden cessation of the current would produce an electrical tension so dangerously high (evidenced by the brilliant spark of interruption) as to unnecessarily strain the capabilities of the insulation of the machine.

Interruption of the current arising from the extinction of the light is not dangerous, as a considerable decrease in current strength always precedes extinction; but, as has been stated, it is the consequent increase of speed, by the sudden withdrawal of the load from the motor, that might have a dangerous result. This result would, of course, depend upon the condition and control of the motor, the size of its fly-wheel, &c., and would be modified thereby. These conditions of control are placed most favourably in the engines supplied with the machine, but attention to the conditions is always necessary.

When it is desired *to divert the current into another circuit*, it is always advisable to *stop the machine*.

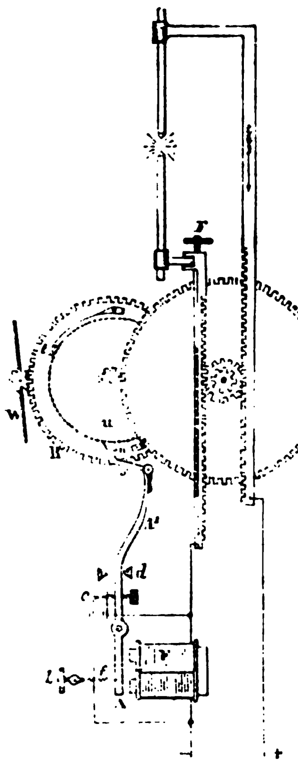
Self-acting lamps have hitherto been constructed chiefly upon the basis of a clockwork action, employed to approximate the carbons to a certain point, when, by the influence of an electro-magnet, the clockwork being checked, the carbon points are allowed to burn away to such a distance that, consequent upon the decrease of current, the clockwork is again released, and the carbons caused to approach to their position of least distance.

The lamp here described is actuated *without*

clockwork, which has always been a source of numerous failures and difficulties, and liable to disarrangement upon the least rough usage. This lamp also *distances* the carbon points when they have approached too closely or touch. By this united action of distancing and approaching the carbon-points are automatically kept at a uniform distance, and a perfectly steady light is obtained.

The working parts of the lamp are represented in the diagram, Fig. 8.

Fig. 8.



E is the horse-shoe electro-magnetic motor, with the armature A opposite its poles. A spiral spring, *f*, the tension of which can be regulated by the screw, *b*, withdraws the armature from the poles of the electro-magnet, and brings its elongation A¹ against the stop *d*. When a current of sufficient strength to overcome the tension of the spring, *f*, circulates in the coils of the electro-magnet, the armature will be attracted, and contact established at *c*, which, offering a shorter route, diverts the current from the coils of the electro-magnet into the shunt. The consequent release of the armature from the poles of the electro-magnet reopens the contact at *c*; the armature is again attracted, and the action is repeated during the use of the machine. When, therefore, the carbon-points are so close that the resistance of the electric arc (of light) is sufficiently small to maintain a current in the coils just powerful enough to overcome the tension of the spring *f*, the armature commences to oscillate, and continues to vibrate while the current is of the same intensity.

The spring-pawl, *s*, at the extremity of the arm A¹, oscillating with the arm, actuates a fine-toothed ratchet-wheel, *u*, in gear, by a train of wheels and pinions, with the racks of the carbon-holders, and thus resists and overcomes the gravitating tendency of the upper carbon-holder, slowly parting or distancing the carbons. Increase of resistance results from this distancing of the carbons, and the current becomes proportionately weaker; the armature ceases to oscillate, and again rests upon the stop *d*.

In this position the spring-pawl, *s*, bearing its inclined face against a pin, *n*, is released from the teeth of the ratchet-wheel, *u*; the preponderating weight of the upper carbon-holder now comes into play, and the carbons are approached to each other, the spur-pinion on *u* taking an opposite direction to that which it has when under the influence of the ratchet-wheel. Increase of current follows the decrease of resistance consequent upon the decrease of length of the electric arc; the armature again oscillates: and this cycle of action is continuously repeated.

The speed at which the carbons approach is regulated by the fly W, the driving-wheel (R) of which is fitted loosely upon the axle of the ratchet-wheel, and coupled to this wheel by the spring detent *t*, the detent acting only when the carbons approach.

When in action the alternating movements of the carbons is scarcely perceptible, but when, by any exterior influence, the light is extinguished, the carbons immediately run together, ignite as soon as contact is established, and work apart under the action of the electro-magnet, to the distance determined by the tension of the spring *f*.

Too slack or too little tension of the spring would cause the electro-magnet to separate the carbons too widely, thereby extinguishing the light and producing a flashing light, burning, extinguishing, and relighting at regular intervals. If the spring be too taut or at too high tension the carbons would not separate, the electro-magnet remaining inactive.

The only object requiring attention in the use of this lamp is the *tension of the spring f*. When this tension is regulated and adapted once for all to the strength of current at disposal, the lamp will continue to throw a constant light so long as the current remains constant. A source of electricity varying in strength demands corresponding regulation of the tension of the spring.

The method of regulating the lamp is the same whether a constant current of one direc-

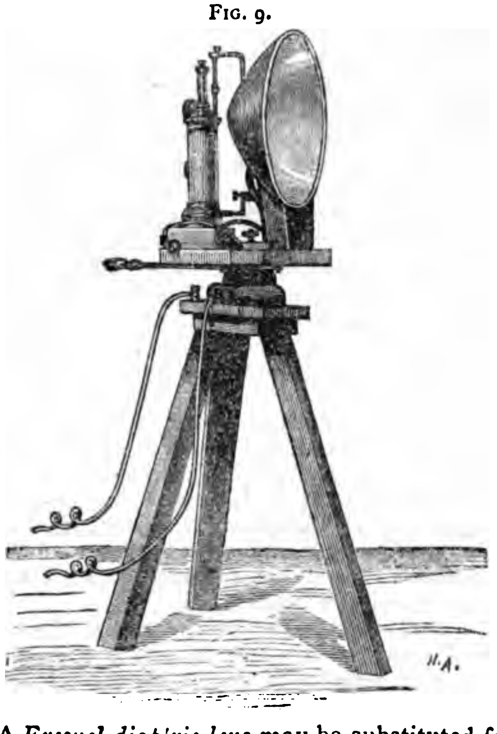
tion or intermittent currents of opposite direction are employed for the light. With the latter the oscillations for the armature would take place even without the assistance of the shunt-contact *c*.

But as the proportion of the consumption of the carbon-points differs, the positive carbon burning about twice as quickly as the negative, provision is made that the racks, which are fixed to the negative carbon-holder, may be made at will to gear (by turning the thumb-screw F) either into the teeth of the same pinion as the positive carbon-holder, or into a pinion of half the diameter. By these means the light, when once focussed in a reflector, will remain in focus as long as the carbons last, whether permanent or reversed currents are employed.

Two kinds of concentrating apparatus are supplied in combination with the automatic lamp.

The *parabolic* reflector is of stout plated copper, inside brightened. The apparatus is mounted upon a wooden stand, as shown in Fig. 9, and can be directed to any point by means of a ball-and-socket joint.

Fig. 9.



A *Fresnel dioptric lens* may be substituted for the parabolic reflector. This lens is contained in a metal case, inside which the lamp is placed upon a slide, to admit of obtaining the focus. The entire lamp revolves horizontally upon rollers, and swings upon pivots, to obtain any desired inclination.

Both apparatus are provided with a lens, by means of which an image of the burning carbons is thrown upon a small screen of frosted glass: the carbons can thus be easily adjusted without fatigue to the eye.

SOCIETY OF TELEGRAPH ENGINEERS.

At the meeting on November 24th a paper was read by the Secretary, Mr. G. E. Preece, "*On Cable Borers.*" It appears that when repairing the Holyhead Dublin Cable it was found that the inner hemp serving was eaten away by worms, two or three different species being noticed. Some specimens of these worms were forwarded by Mr. Culley to Dr. Carpenter, who, in his Report, remarks—" Dr. Mackintosh recognises three types, *Lepidonotus equimalis*, *Evarne impar*, and *Nereis pelagica*, all well-known British forms, and says—' I agree with you in acquitting them of all share in making the perforations in the coverings of the cable. They had only been lurking (after their wont) in the holes made by other forms.' The Rev. William Norman agrees with me in identifying the minute crustacean as the *Limnoria lignorum* of Rathké, known to British naturalists as the *Limnoria terebrans*. Clearly, therefore, it is the *Limnoria* that does the mischief to your cables. As its ravages were long ago noticed at Dublin, it must be an old inhabitant of the Irish Sea. It is so small a creature that it would seem to me that the overlapping copper riband of Messrs. Siemens would afford a surer protection."

The Report of the President and Council for the year 1875, which was read at the Annual General Meeting on the 8th inst., showed an increase during the year of 41 foreign members, 25 members, 47 associates, and 2 students. The total number of members, associates, and students is now 763.

The following gentlemen were elected officers for the year 1876:—

President—C. V. Walker, F.R.S.

Vice-Presidents—Prof. Abel, F.R.S.; Major Bateman Champain, R.E.; R. S. Culley, C.E.; Prof. G. C. Foster, F.R.S.

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Associates—O. Heaviside; J. Sivewright; W. J. Tyler.

Hon. Treasurer—Major Webber, R.E.

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The Annual *Soirée* of the Society will be held on Tuesday next, at Willis's Rooms.

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Inaugural Address of Sir John Hawkshaw, F.R.S., the President of the British Association for the Advancement of Science—Distribution of Magnetism in Bundles of Very Thin Plates of Finite Length, by Jules Jamin—On Statical Electricity and Superficial Tension of Liquids—Note on Schwendler's Duplex, by A. Eden—Pneumatic Relay Telegraphs for Long Distances—History of Magneto-Induction Machines with Uninterrupted Current of Invariable Direction—Notices of Books.

No. X.

British Association for the Advancement of Science: Section A., Mathematical and Physical Science; The President's Address—Quadruplex, by A. Eden, Assoc. Soc. Tel. Eng.—On the Decomposition of an Electrolyte by Magneto-Electric Induction, by J. A. Fleming, B.Sc. (Lond.), F.C.S., Cheltenham College—On Phenomena Produced by High Potential Electric Currents, and their Analogies with Natural Phenomena, by Gaston Planté.

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London: Printed and Published by the Proprietor, WILLIAM CROOKES, at the Office, Boy Court, Ludgate Hill, E.C. December 15, 1875.